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THE ANCIENT CITIES OF YUCATAN.

VISITORS to the Columbian Exposition, at Chicago, will remember the very excellent reproductions of the architecture of the ancient Americans, which showed the forms in which these interesting but little known peoples were accustomed to build and the curious ornamentation with which they covered their completed homes and temples. The Field Columbian Museum—an outgrowth, by the way, of the great exposition—has recently published the first part of volume one of a work by Mr. W. H. Holmes, Curator of Anthropology, entitled "Studies among the Ancient Cities of Yucatan." The report, which is freely illustrated, gives the result of a three months' tour through southern Mexico, mainly in the states of Yucatan, Chiapas and Oaxaca, which was undertaken by the writer for the purpose of examining the famous archeologic remains of those countries.

It is recorded by the early Greek historians that the middle Atlantic Ocean was once a great continent, known as Atlantis, inhabited by an energetic and enlightened people, who pushed their conquests "to the farthest limits of the Mediterranean, and that the Greek gods, in anger at these encroachments, retaliated by sending Atlantis to the bottom of the sea." Whether one continent has disappeared or not, "it is a curious fact that another land has risen from its watery bed." Geology proves that "Yucatan is a new-born realm." The local limestone is full of fossil shells of living species, and "represents late pliocene or early pleistocene times, thus possibly bringing the date of the elevation of Yucatan down somewhat near to that of the reputed sinking of Atlantis, some eleven or twelve thousand years ago, or not far from the period which witnessed the oscillations attending the close of the glacial period." It has been contended by many students that the American races may have been derived from the inhabitants of Atlantis, and that the culture represented in the ruined cities of Yucatan may have had its birth among the submerged race.

The Maya Race.—At the period of conquest the Maya tribes, occupying the peninsula of Yucatan and considerable portions of neighboring territory to the south and west, are said to have comprised in the neighborhood of two million souls. To day they are distributed over nearly the same area, but are reduced in numbers, it is estimated, to less than five hundred thousand, half, at least, of whom continue to speak the Maya tongue in its purity. At the north, where there has been much infusion of Spanish blood, the race has been largely modified, and an interesting and very homogeneous half-blood people has sprung up; but in the interior many of the tribes are of nearly pure blood and retain a strong spirit of independence. It is said that some bands have never been fully conquered, and they practically substantiate the claim by holding the temples of their fathers by force of arms, defying all comers, whether white or red.

ORNAMENTATION OF EAST FACADE, GOVERNOR'S PALACE, UXMAL.

They were the most cultivated of the American tribes, and "seemed to be on the very threshold of civilization." The history of this remarkable people is chiefly written in their architecture; though they had also progressed in other of the useful arts. They made paper of maguey and show advanced skill in pictographic and glyphic writing. Their language is highly developed, and its grammatical construction is more like the English than that of any other American tongue. They practiced agriculture, and were averse to war.

"Monumental Remains.—Maya architecture, with its associated sculpture and painting, constitute the best remaining index of the achievements of the race. The seventy thousand square miles of Maya territory are so dotted with the ruins of towns and cities that the traveler is seldom out of sight of some mound, pyramid or other massive structure. The preservation of these remains is wonderful, considering the four hundred years of decay and destruction through which they have passed. There is hardly a modern village or town on the peninsula of Yucatan that is not built in some part of materials derived from the ancient structures." Nature and man are both active agents in destroying these remains of an ancient people; and, unless some effort be made by the Mexican government to protect them, the history of the ancient Mayas will, in time, be represented only by the books in which it is written.

It is probable that the Mayan buildings, of which we see the ruins, were devoted to the uses of religion. They are built at the top of pyramids, are approached by steep stairways, and are unsuited for domestic purposes. It is likely that the houses of the people were built largely of wood and thatch, and were similar in appearance to the older dwellings to be found today among the modern Mayas. There is but little evidence that the Mayas built with a view to defense. They were a peaceable people, and the great thickness of their walls and the massive forms in which they put up their temples was due to their ignorance of the true principles of construction, such as, in a later age, enabled the Gothic architect to carry up his slender buildings to such lofty heights.

They found their building materials ready to hand in the massive, underlying beds of limestone. They used "a mortar, made of lime and sand, and cementlike mixtures composed of mortar tempered with gravel, pounded stone etc., whose durability is remarkable." Wood was extensively employed, particularly for the lintels of doorways. In constructing the larger buildings, vast quantities of stone were necessary, and though they did not employ blocks of the same enormous size as did the ancient Mexicans and Peruvians, single blocks are found that weigh from six to eight tons. Perhaps the most wonder-

TEMPLE OF THE TIGERS AND EL CASTILLO, CHICHEN-ITZA.

ful evidence of the patience and skill of these people is to be found in the mass of elaborate carving and ornamental stonework with which they covered their buildings. The broad sculptured façade of the governor's palace, at Uxmal, contains upward of "twenty thousand stones, not only hewn of varied, special shapes, but each sculptured to represent some individual part of a face, figure or geometric design, and all fitted together with such skill as to give the effect of an unbroken whole."

Maya statuary was conventional and crude; but, as it was intended for architectural embellishment, it was in proper keeping with the design of the buildings.

The masonry consists mainly of hearting of earth, mortar, and stones, and facing of cut or uncut stone, laid in excellent mortar. The walls and the masonry above the spring of the arched roofs are extraordinarily massive. In a single-chamber structure two-thirds of its bulk would be solid masonry. The governor's palace occupies about 325,000 cu. ft. of space, of which only about 110,000 cu. ft. is chamber space.

Mr. Holmes also points out that they were ignorant of some of the most essential principals of stone construction, for they never laid their facing stones so as to break joint, nor is the masonry anywhere bonded, the outer covering being held against the building merely by the mortar. Stucco was extensively used in decoration, and nearly all surfaces, exterior and interior, where effect was aimed at, were finished in color.

The ancient cities were built upon plains, and, to compensate for the lack of bold natural features, the Mayas constructed vast terraces and pyramids, upon which they erected their buildings. Some idea of the size and extent of these works may be gathered from the accompanying panoramic views, which were sketched by Mr. Holmes on the spot. The largest of these raised terraces or platforms is 500 feet in length and width, and the loftiest is nearly 100 feet in height. Their sides were usually faced with stone, which was dressed smooth or plastered. On one or more sides they were ascended by steep and wide stairways. The ground plan of the buildings was usually rectangular, and the single-room buildings consisted of a long and narrow cell, with a solid, arched roof, of high pitch. The larger buildings are "little more than a mere reduplication of the single cell unit."

"The treatment of the facades of their buildings indicates a pronounced love of display on the part of the builders, and in many cases at least nine-tenths of the labor expended on a building is represented in show alone."

The openings into the buildings consist chiefly of doorways, though there are occasionally to be found small square openings that may have been intended to admit air and light. The doorways are usually well defined, with jambs, wooden lintels and sometimes sills. One of the finest openings is 20 feet wide and 8 feet high, and is divided by two massive columns sculptured to represent feathered serpents.

Mr. Holmes considers that the columns used by these ancient builders constitute a characteristic American type. The serpent columns consisted of a base formed by the head of the serpent, a shaft formed by the body, and a capstone, which consists of the tail of the serpent, which was turned abruptly out for this purpose.

SCULPTURED SANCTUARY, TEMPLE OF THE TIGERS, CHICHEN-ITZA.

Uxmal.—The area covered by this group of ruins is about half a mile square.

There are five great structures or groups of structures that take high rank as specimens of Maya architecture. These are the Pyramid Temple of the Magician, the quadrangle called the Nunnery, the House of the Turtles, the House of the Pigeons and the Governor's Palace.

In the panoramic view we are looking to the south.

The Nunnery Quadrangle.—This is indicated by let-

EAST FACADE AND IGLESIA, NUNNERY OR PALACE, CHICHEN-ITZA.

ter B. It consists of four great rectangular structures low, heavy and formal in general conformation. They stand upon a broad terrace in quadrangular arrangement, and their ornate fronts face inward upon the inclosed court. At first glance they suggest the appearance of a fortification. But closer inspection makes it evident that they were used as temples or residence

for bodies of priestly orders. In the panoramic sketch we look down upon the great quadrangle from the north.

The Governor's Palace.—To the south of the Nunnery rises the broad, triple terrace of the so-called Governor's House or Palace (E). The superb building which crowns its summit is justly regarded as the most important single structure of its class in America.

It is extremely simple in plan and outline, being a trapezoidal mass some 320 feet long, 40 feet wide, and 25 or 26 feet high. It is partially separated into three parts, a long middle section and two shorter end sections, by recesses leading to two great transverse archways now walled up, but formerly passing quite through the mass.

The front wall is pierced by nine principal doorways, now much broken down above, and by the two archway openings, and presents a façade of rare beauty and great originality, as may be seen from the accompanying illustration, which shows a section of the embellished entablature zone of the palace.

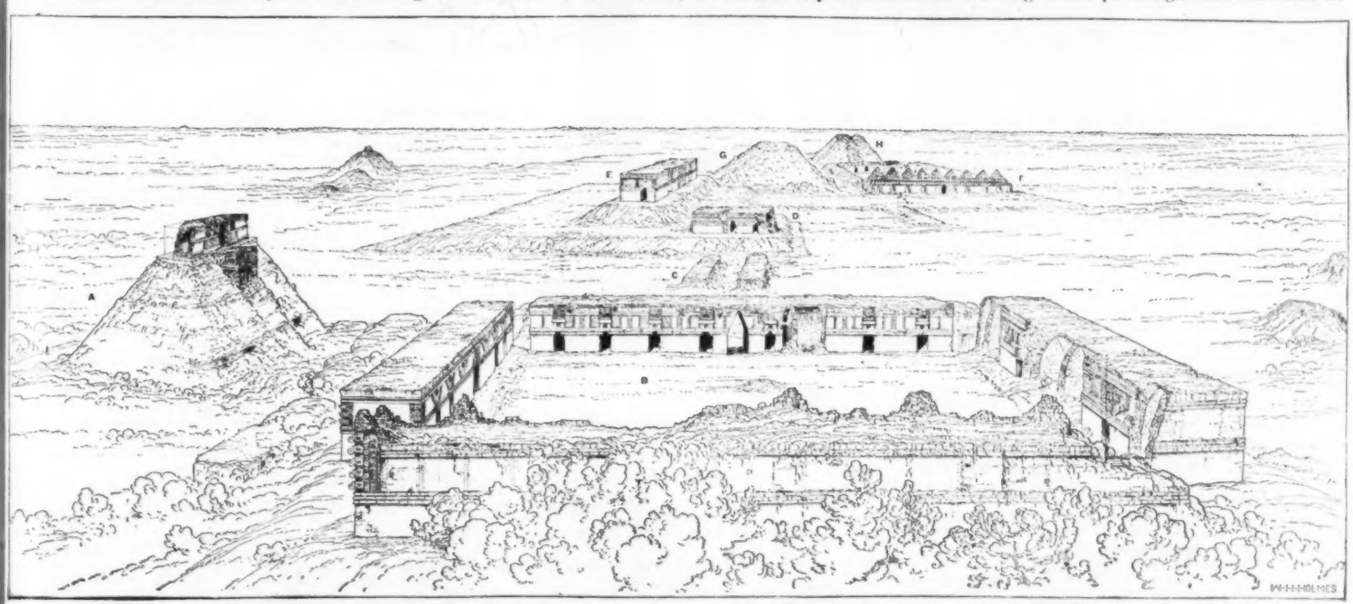
"The height from the lower or medial moulding below to the coping course above is about ten feet. The entire length, covering the four walls of the building, is some 725 feet. If we allow that the stones employed average six by twelve inches in surface dimensions, this deeply coffered and relieved mosaic would comprise upward of 20,000 pieces, all especially cut and a large percentage elaborately sculptured. Two plain coping courses are seen at the top, followed by a twined fillet moulding, while under this is a line of very ornate snouted masks. The broad space below is filled with bold fretwork, set on a lattice ground and interrupted by the wonderful over-door trophy, the central feature of which is a human figure, fully life size, sculptured in the round and seated in a niche with festooned base. The head was where the minute white cross now appears, and was surmounted by an elaborate and colossal headdress, most of which remains. The horizontal bars terminating in serpent heads at both ends are separated by lines of hieroglyphs."

House of the Pigeons.—This unique structure (F), seen in the panorama to the southwest, is the ruin of the north building of another remarkable quadrangle, which could appropriately be called the Quadrangle of the Nine Gables. The illustration shows the central part of this building, the partitions and back walls of the front tier of chambers appearing at the base behind the white figures.

"The ancient builders certainly did not lack originality and boldness. Here was a great building, of unusual construction and size, with an arch opening through the middle into a court—as in the south building of the Nuns' Quadrangle—bearing upon its roof a colossal masonry comb built at an enormous expenditure of time and labor. Above the mouldings the wall is divided into nine sections, which rise in steps to some twelve feet in height, terminating in points now somewhat broken down. Only eight of these pinnacles are still standing, though I have taken the liberty of showing the full number in the panorama.

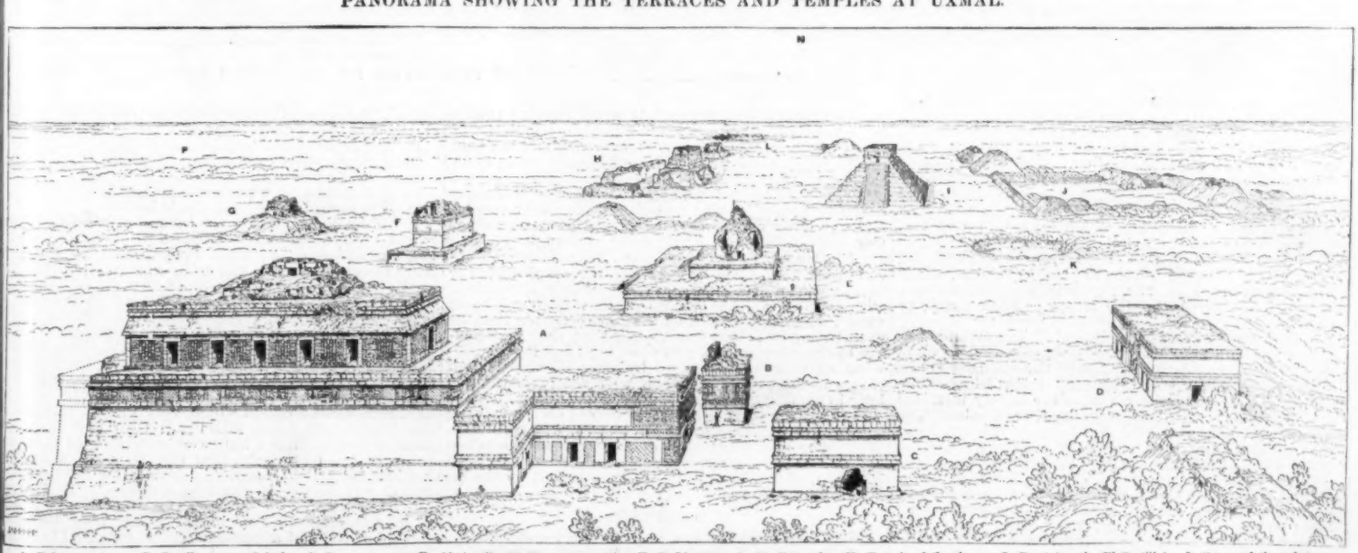
"In the middle of the picture is seen the remaining portion of the vaulted portal which led through the north building of the quadrangle into the court be-

MIDDLE PORTION OF THE HOUSE OF THE PIGEONS, UXMAL.



A. House of magician. B. Grand quadrangle, nunnery. C. Gymnasium walls. D. House of turtles. E. Governor's house. F. House of pigeons. G. Great pyramid. H. S. W. temple. I. House of the old woman.

PANORAMA SHOWING THE TERRACES AND TEMPLES AT UXMAL.



A. Palace nunnery. B. Smaller annex, Iglesia. C. Larger annex. D. Akab-tzil. E. Tower (Caracol). F. Red house. G. Small temple. H. Temple of the tigers. I. Great temple (El Castillo). J. Group of the columns. K. Great well. L. Small temple.

PANORAMA SHOWING THE TEMPLES AND PYRAMIDS IN THE PLAINS AT CHICHEN-ITZA.

yond. The façade has entirely disappeared, and sections of the front range of rooms are seen, displaying the solid masonry of partition walls and roof. Above is the remarkable roof comb, which extended the entire length of the building along the middle of the roof. Below is the long monotonous line of doorlike openings which penetrate the comb wall, having no function other than that of ornament. Above is the rigid line of mouldings, and over this are shown five of the nine perforated gables, erected for no other purpose than that of holding aloft elaborate sculptured decorations."

Chichen-Itza—the mouths of the wells of Itzas—is the name given to the most important group of ruins in Yucatan; although it has no single monument to rival the Governor's Palace or the Nunnery Quadrangle at Uxmal, it outranks that city in extent and in the number and variety of its remains.

The principal ruins are inclosed within a space considerably less than a mile square, and consist of half a dozen important piles, with numerous scattered remains of inferior structures. The pyramid temple may be regarded as the prevailing type of structure. The roof is level, and surfaced with cement, and the floors are also cemented. The arches employed in ceiling are wedge-shaped. The sculptured work is characterized by "rude vigor," and is used almost exclusively for architectural embellishment. "The function of the temples was in the main religious, the typical temple prevailing over all other forms of building."

"The Nunnery or Palace.—The so-called Nunnery or Palace (A), seen in the immediate foreground of the panorama, is one of the most interesting and important buildings in Chichen. It has associated with it at the right two smaller buildings or annexes (B and C). The group appears to rest almost directly upon the original surface of the site, which was, however, somewhat uneven, necessitating a good deal of leveling up, as on the south side or back, where there is considerable descent from the base of the walls. A little in the rear, and to the southeast, just outside of the view, is a deep conical sink, possibly representing an extinct cenote."

In the accompanying illustration "the east front of the ground floor section of the Nunnery or Palace is seen at the left. It is characterized by unusually bold and effective ornament, both lower and upper wall zones being covered with sculptures. Two lines of snouted masks appear in the lower zone and one line in the upper. The medial and frieze mouldings are embellished with geometric ornaments and the coping course is sculptured. The doorway is an elegant piece of work and is unique in many respects. Above is a center piece of much interest, the main feature of which is a human figure, probably representing a chief deity, in high relief, seated in an arched niche, with the usual conventional feather designs at the right and left. At the right is the Iglesia annex, a single room structure, similar to the main building in general treatment, but having a plain lower wall zone. The façade, which is on the west side and not visible in the plate, is surrounded by a high, richly decorated false front. Mask snouts, most of which are broken, are seen in profile at the corners. Photographed by Dr. C. F. Millspaugh."

El Castillo.—The noblest monument of Chichen is the so-called Castillo or Castle (I), seen to the right of the Temple of the Tigers and near the middle portion of the panorama, rising grandly above the forest covered plain. It is a pyramid temple of the first order and bears testimony to the developing taste of the Itzas, as well as to their capacity for designing and carrying out constructional enterprises of grand proportions. It is perhaps as nearly a consistent unit of building, according to our estimate, as can be found in the Maya country, though there are still suggestions of lack of maturity and refinement. It embodies only two principal features, the square, terraced pyramid and the blocklike superstructure. The pyramid is between seventy-five and eighty feet high and measures some 200 feet square at the base and about sixty feet square at the top. The stepped sides rise at an angle of fifty degrees. The stairways, four in number, assist in breaking up the severity of the pyramidal mass. They are constructed of small blocks of roughly hewn stone, now much displaced in places.

The temple consists of a vestibule, an inner sanctuary, and an inclosing gallery, the whole being roofed in with the characteristic vault roof. This building is an excellent type of the Maya pyramid temple.

The Temple of the Tigers (H).—This is seen to the left of the illustration, and in the panoramic view it lies toward the left hand corner.

The view is taken from the south end of the west wall of the gymnasium, looking east. In the foreground at the left is the solid mass of the east wall of the gymnasium supporting the ruined Temple of the Tigers. The plain hewn stone wall is seen below, and rising from its margin to the temple level is the short stairway. The façade of the temple has disappeared, save the lateral piers and the stumps of two great serpent columns which stood in the portal; the open mouths of the serpents, showing nostrils and bulbous fangs, face the observer. Back of the columns is the rear wall of the vestibule, with its characteristic masonry, and the doorway which leads to the pictured sanctuary. The end wall of the vestibule is seen at the right sloping to a point above, while one of the capstones of the vault is seen in place at the left. This building is noted for the rich wall sculptures which adorn what remains of the sculptured sanctuary, or chamber.

"They represent richly bedecked figures arranged as if to represent some ceremony or dance, and most of them still retain distinct traces of the brilliant colors with which they were originally embellished. The sculptures covering the columns are nearly identical with square column decorations in other temples. The figure of a man occupied the front of the left hand column and that of a woman—as indicated by the plaid skirt—the right hand column. Between the columns stands the rather rudely sculptured and very formal figure of a tiger. This may not have been its original position. Length of the chamber, twenty-two feet; width, ten feet; height, fifteen feet."

Space forbids a further review of these most interesting archæological studies of a people of whom we know but little, and should know more. Our thanks are due to Mr. F. J. V. Skiff, Director of the Field Columbian Museum, for the accompanying illustrations, which are selected from Mr. Holmes' valuable work.

AUTOMATIC FIRING GUNS.

By HIRAM STEVENS MAXIM.*

I.—HISTORICAL.

THE early forms of fire arms were of great simplicity. For the most part they consisted of an iron tube, all in one piece. The process of loading and firing was both slow and uncertain. First a measured quantity of powder was placed in the bottom, or closed end of the tube. On top of this was placed a wad of paper or tow, then the projectile, and on top of this again another wad to keep the projectile in place. A small hole bored through the rear end of the tube, and technically called the touch hole, was employed for "touching off" the charge, which, in the original guns, was accomplished by a match or fuse, and in those of later dates, by sparks generated from the contact between flint and steel.

As the science of gunnery progressed, the gun maker sought not only to increase the range of the arm, but also the rapidity of fire, and it would appear that a large number of the early inventors first thought of the revolver principle as the means which would lend itself most readily to this end. Nothing would seem simpler than to make the rear of the arm in such a manner that a loaded cylinder carrying several charges could be inserted, and these charges brought successively in line with the barrel and fired. The revolver was, in fact, among the first systems thought of by a considerable number of inventors. But it would appear that very little was actually accomplished, the inventors, for the most part, contenting themselves with making a single example of their arm, and these were looked upon more as curiosities rather than as useful weapons. The inventor at that time, not having the percussion cap, was obliged to employ a somewhat cumbersome means of igniting his charge, and this was the probable reason why revolvers were so long in coming to the front.

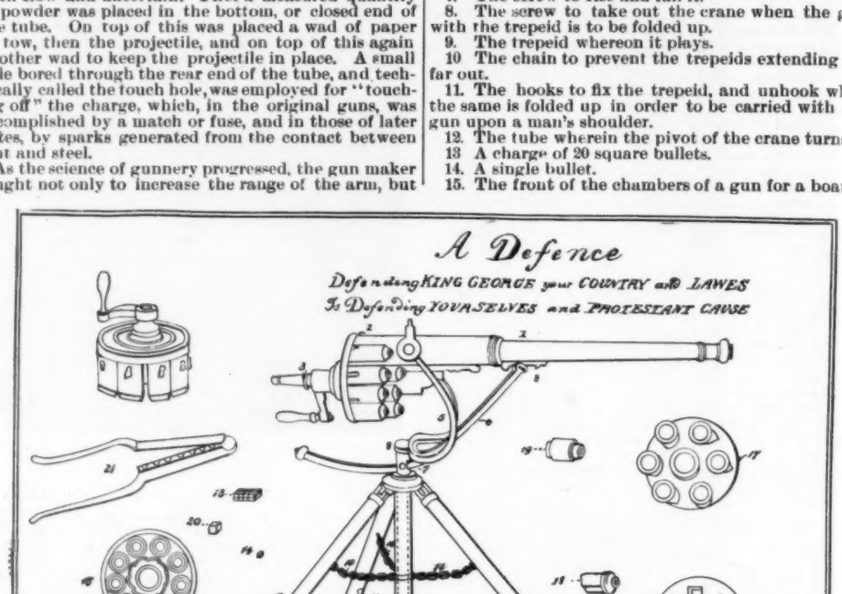
Perhaps the most remarkable patent on a revolving fire arm is that granted to Puckle, No. 418, 15th May, 1718. The accompanying illustration has been taken from the original drawings attached to the patent, and a portion of the description which was filed by the inventor is as follows:

A DEFENCE.

Defending King George, your Country and Lawes
Is defending Yourselves and Protestant Cause.

A portable gun or machine, called a defence. For bridges, breaches, lines, and passes, ships, boats, houses, and other places.

1. The barrel of the gun.
2. The sett of chambers charg'd put on ready for fireing.
3. The screw upon which every sett of chambers play off and on.
4. A sett of chambers ready charg'd to be slipp'd on when the first set are pull'd off to be recharg'd.
5. The crane to rise, fall, and turn the gun round.
6. The curb to level and fix the guns.
7. The screw to rise and fall it.
8. The screw to take out the crane when the gun with the trepeid is to be folded up.
9. The trepeid whereon it plays.
10. The chain to prevent the trepeids extending too far out.
11. The hooks to fix the trepeid, and unhook when the same is folded up in order to be carried with the gun upon a man's shoulder.
12. The tube wherein the pivot of the crane turns.
13. A charge of 20 square bullets.
14. A single bullet.
15. The front of the chambers of a gun for a boat.


A Defence
Defending KING GEORGE your COUNTRY and LAWES
& Defending YOURSELVES and PROTESTANT CAUSE
Invented
by
Mr JAMES PUCKLE
For Bridges Breaches Lines and Passes
Ships Boats Houses and other Places

Whereas our Soveraign Lord King George by his Letters patents Bearing date the Fifteenth day of May in the Fourth Year of his Majesties Reign was Graciously pleas'd to Give & Grant unto me James Puckle of London Gent my Exors Admors & Assignes the Sole privilege & Authority to Make Exercise Worke & use a Portable Gun or Machine (by me Lately Invented called a Defence in that part of his Majesties Kingdom of Great Brittain called England viz. Dominion of Locales Town of Berwick upon Tweed and his Majesties Kingdom of Ireland in Such manner & with Such Materials as I Shou'd be Ascertain'd to be the Sd New Invention by writing under my Hands Seal and Inrolled in the High Court of Chancery within Three Calender days Months from the Date of the Sd patent as in & by his Majtie Letters Patents Relation being thereunto had Doth & may amongst Other things more fully & at Large appear Now I the said James Puckle Do hereby Declare that the Materials whereof the Sd Machine is Made are Steel Iron & Brass and that the Trepied whereon it Stands is Wood & Iron And that in the above print (to which I hereby Refer) the said Gun or Machine by me Invented is Delineated & Described July the 25th 1718./

SP 180

Jas Puckle

BREECH LOADING MAGAZINE GUN PATENTED BY MR. JAMES PUCKLE IN 1718.

16. The plate of the chambers, for a gun for a ship, shooting square bullets against Turks.
17. For round bullets against Christians.
18. A single square chamber.
19. A single round chamber.
20. A single bullet for a boat.
21. The mould for casting single bullets.

It will be observed that the inventor proposes to use round bullets against Christians, presumably Catholics, and square ones against Turks. Had his Majesty King George been at war with any heathen nation at the time, it may be presumed that he would have recommended a bullet to be used against them still more angular than that recommended for Turks, while he might have recommended the employment of soft bullets made of cork or wood against his own erring co-religionists, the Protestants. However, the illustrations forming part of the patent are certainly interesting in their way. It will be seen that the arm is mounted upon a tripod which very closely resembles the tripods employed with the Gatling and Gardner guns of to-day, that a too great spreading of the legs is prevented by a chain, that stiff rods are used for holding the legs in position, and that for holding the gun at any degree of elevation a device is employed almost identical with that used on some recent forms of machine guns. This arm, I think, may be considered as the first mitrailleuse ever patented in England.

Notwithstanding the comparative antiquity of the principle of making a revolver, it would appear that

* Industries and Iron.

nothing practical was ever done with it till more than twenty years after the invention of the percussion lock. In 1835 Colonel Samuel Colt, of Hartford, Connecticut, commenced his experiments with a view of producing a practical revolving fire arm, but it was not until ten years later that he considered the revolver had been sufficiently perfected to be offered to the public as a practical arm. It would appear that he did not make the mistake, so common to most inventors, of offering his arm to the military authorities or to the public while it was still in the experimental stage. The advantages of a revolving fire arm were so great that the new arm was at once taken up by nearly all the military authorities in the world, and perhaps no fire arm ever met with so great a success as the Colt revolving pistol. At first it was generally believed by the public, especially in America, that the revolving system was completely new, and that it was wholly the invention of Colonel Colt. It was not until many years later that the public became aware of the fact that a revolving fire arm had been invented many years before the Colt revolver. However, I think I am justified in saying Colonel Colt should be considered as the originator of revolving fire arms, because he was the first to ever make a practical arm on this principle. He was the first to ever put upon the market a serviceable revolver, and is, I think, entitled to all the profit and credit that he has received for the work that he has accomplished in this direction.

The cartridges employed in the early Colt revolver were made in the following manner: A little sack of oiled silk, having the diameter of the bore and a length slightly greater than the powder charge, was first filled with powder, and then the projectile inserted, the sack being attached to the base of the projectile by a cotton thread. Common percussion caps were employed. Upon the fall of the hammer the blast from the fulminating cap penetrated the sack and ignited the charge. The projectiles were pressed into the cylinder by means of a lever and piston articulated to the arm in such a manner that the projectiles could be firmly pressed into the cylinder without removing it from the frame of the revolver. In regard to the place that Colonel Colt is entitled to as the inventor of the revolver, I quote the following from an American publication:

"Colonel Colt obtained his first patent in 1835, but his weapon was not perfect until 1845. On visiting England, he undertook to investigate the origin of repeating fire arms, and the result of his researches was that arms similar in principle to his own revolver had been invented four centuries before.

"In the Tower of London he was shown a matchlock gun, dating back to the fifteenth century, and closely resembling in the principle of its construction the revolver of the present day. It has a revolving breech with four chambers mounted on an axis fixed parallel to the barrel, and on that axis it may be turned round to bring any one of the four loaded chambers in succession in a line with the barrel, to be discharged through it. There are notches in a flange at the fore end of the revolving breech to receive the end of a spring which is fixed to the stock of the gun for the purpose of locking the breech when a chamber is brought round into the proper position. The hammer is split at the end, so as to clasp a match, and carry its ignited end down to the priming powder, when the trigger is pulled. Each chamber is provided with a priming pan that is covered by a swing lid, and before firing, the lid is pushed aside by the finger, to expose the priming powder to the action of the lighted match. In the lower armory was a specimen of a repeating fire arm of a more recent date, though still very ancient, and presenting considerable improvement on the preceding one. It has six chambers in the rotating breech, and is furnished with a barytes lock and one priming pan to fire all the chambers. The priming pan is fitted with a sliding cover, and a vertical wheel with a serrated edge projects into it, nearly in contact with the powder in the pan. To this wheel a rapid motion is given by means of a trigger spring, acting upon a lever attached to the axis of the wheel, and the teeth of the wheel strike against the barytes, which is brought down, previously to firing, into contact with it, and the sparks thus emitted set fire to the powder in the priming pan and discharge the piece. In this instance also, the breech is rotated by hand."

Colt's revolver appears to have been used to some extent by the allied forces in the Crimean war, but I remember that it was said at the time that the superstitious rank and file of the Russian army believed that the officers of the allied forces possessed a miraculous pistol, which could be fired any number of times without reloading by the intercession of the devil – that is, the mention of the name of the devil reloaded the arm.

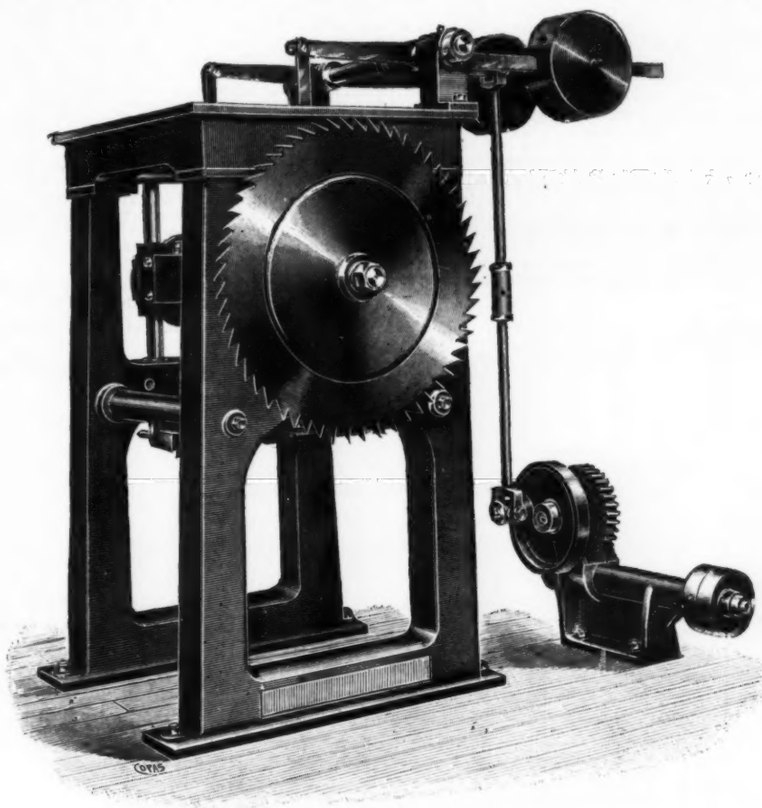
When the Colt revolver first made its appearance, both the United States and Mexico were having a great deal of trouble with the Comanche and Apache Indians, and the Mexican government offered a reward of $200 for every Indian killed. Four young Mexican gentlemen obtained from Germany double barreled rifles and ammunition, from Spain chain armor, and from Colonel Colt revolvers and cartridges, and with these they made war against the Indians wherever they could find them. The Comanches at the time were only armed with tomahawks and bows and arrows. The Mexicans being excellent riders, and mounted on horses which were considerably superior to the ponies of the Indians, had no trouble in overtaking them on the plains. Riding boldly among them and facing the shower of arrows which fell harmlessly upon their armor, they got at close quarters and used their revolvers with great effect. Each man carrying two revolvers was able to fire fourteen shots, and in this manner a large number of Indians were killed, and the reward received from the government amounted to many thousands of dollars. The Comanches, however, very soon found out what they had to expect, and would not allow themselves to be drawn into a fight with any one who possessed a revolver. It was said at the time that these four Mexican gentlemen did more to suppress the raids of the Comanche Indians than a regiment of United States troops could have done, armed as they were with military muskets, mounted on slow horses and encumbered with a heavy baggage train.

But the revolver, like everything else, has had its day, and the next innovation that we may expect in small fire arms will be the automatic pistol. In the revolver there is always a considerable loss of gas between the cylinder and the barrel; consequently, the muzzle velocity of the projectile is never equal to what it would have been provided the same cartridge had been fired from a barrel of equal length where no leakage could have taken place. In the automatic pistol smokeless powder will be employed, the muzzle velocity will be very high, and the range long. We shall be able to fire with greater rapidity, to load quicker, and to hit at a much longer range. But the new arm will not be of greater simplicity than the old; in fact, it may be said that as the rapidity of fire and accuracy increase in fire arms, the complication becomes greater, but the weight of metal required to fire a given number of shots per minute is constantly becoming less.

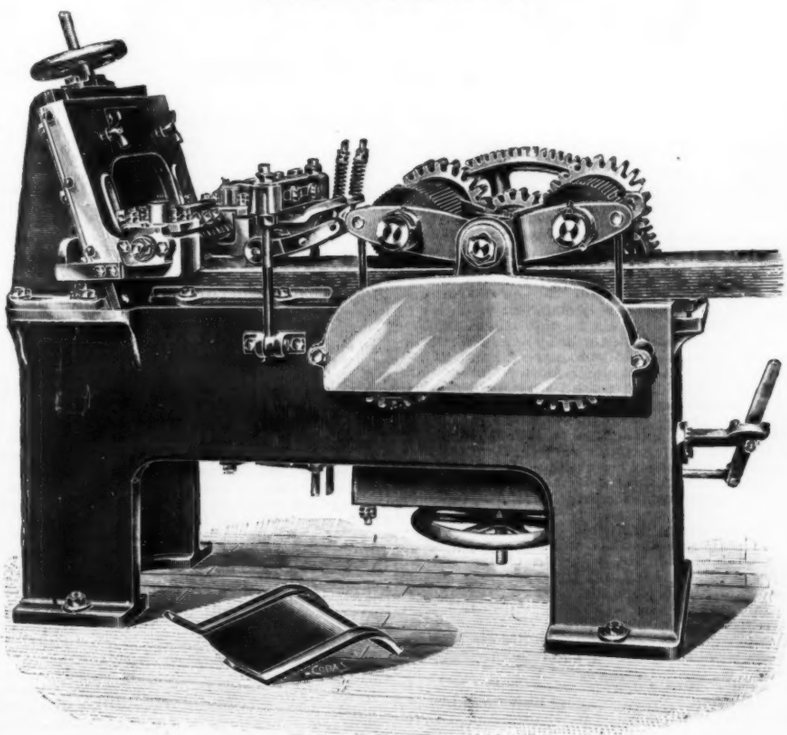
(To be continued.)

WOOD PAVING BLOCK MACHINERY.

THE introduction of the Australian hard woods jarrah and karri for wood paving purposes has proved too heavy a tax on the powers of woodworking machines designed initially for dealing with less refractory materials. Messrs. A. Ransome & Company, Limited, of the Stanley Works, Chelsea, have accordingly recently brought out the two tools which we illustrate on this page. The first machine is a cross cutting saw with which the balks of jarrah, etc., can be cut up into paving blocks very rapidly. As will be seen from the illustration, it consists of a circular saw of large diameter, supported over an unusually great extent of its surface by cast iron disks. These render the saw very stiff, and prevent it buckling even when hard driven. The saw spindle is supported on a carriage which slides on four vertical guide bars. This carriage is balanced by the weighted levers shown to the right of the machine, and is given a reciprocating motion by the crank shown below. This crank is independently driven by worm gearing, the speed being such that the saw makes 32 strokes per minute. This, of course, involves an unusually high speed for the worm gearing, but the latter is run in oil, and by its use it is possible to stop and work the saw in any part of its stroke without any risk of its running



TEMPERLEY'S CROSS-CUT SAW.



TEMPERLEY'S SPECIAL THICKNESSING MACHINE.

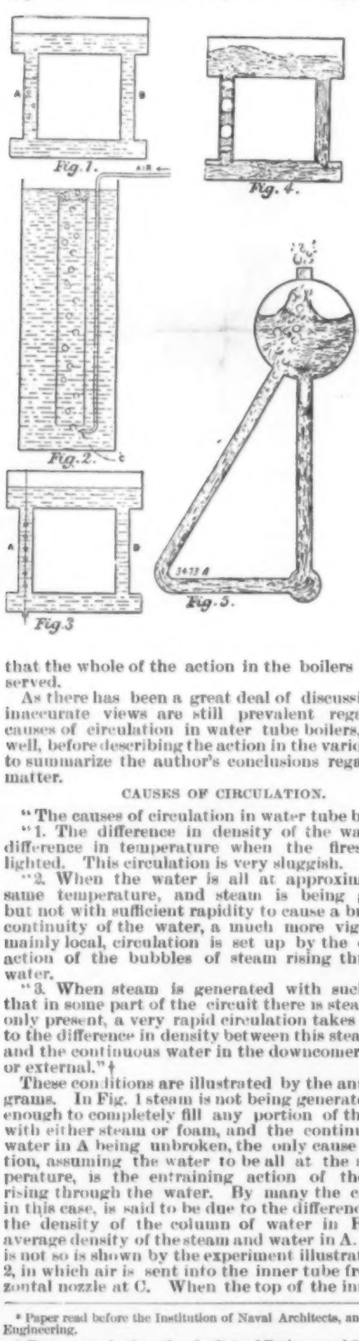
MACHINES FOR PREPARING WOOD PAVEMENT.

down. The balks to be cross cut are introduced below the saw, and rest on a table not shown in the engraving. The attendant slides the timber forward along the table till it comes in contact with an adjustable stop attached to the framing of the machine. The saw then descends and cuts off one block As soon as the saw is clear again on its up stroke, the timber is again fed forward preparatory to another block being cut The output of the machine shown is stated to be 18 000 blocks per day, and in those machines in which a second saw is mounted on the other end of the spindle this number is about doubled. The single saw machine weighs, without table, 43 cwt., and takes about 6 horse power, while the double machine weighs 45 cwt. and takes 10 horse power. Both varieties of the Australian woods named above are liable to twist and warp badly, and as it is essential for paving purposes that the blocks shall be of equal thickness, the second machine illustrated has been designed for planing down the wood on its arrival in this country. As will be seen, it is a planing machine of the ordinary type, but with only a single set of cutters. The framing, spindles, etc., are, moreover, of unusual strength, in view of the extreme hardness of the material to be dealt with. The feed is automatic, and is accomplished by means of friction rollers. The weight of the tool is 41 cwt., and 6 horse power are required to work it. The spindle speed is 1,000 revolutions per minute.—Engineering.

CIRCULATION IN WATER TUBE BOILERS.*

By Prof. W. H. WATKINSON.

THE main object of this paper is to draw attention to a series of models, which will be shown in action at the meeting, and which I have had constructed in order to show the nature of the circulation in the various types of water tube boilers. The tubes in these models are of glass, ranging in internal diameter from ⅜ in. to 1½ in., and the drums are provided with glass ends, so



that the whole of the action in the boilers can be observed.

As there has been a great deal of discussion, and as inaccurate views are still prevalent regarding the causes of circulation in water tube boilers, it will be well, before describing the action in the various models, to summarize the author's conclusions regarding this matter.

CAUSES OF CIRCULATION.

"The causes of circulation in water tube boilers:

"1. The difference in density of the water due to difference in temperature when the fires are first lighted. This circulation is very sluggish.

"2. When the water is all at approximately the same temperature, and steam is being generated, but not with sufficient rapidity to cause a break in the continuity of the water, a much more vigorous, but mainly local, circulation is set up by the entraining action of the bubbles of steam rising through the water.

"3. When steam is generated with such rapidity that in some part of the circuit there is steam or foam only present, a very rapid circulation takes place, due to the difference in density between this steam or foam and the continuous water in the downcomers, internal or external."†

These conditions are illustrated by the annexed diagrams. In Fig. 1 steam is not being generated rapidly enough to completely fill any portion of the tube, A, with either steam or foam, and the continuity of the water in A being unbroken, the only cause of circulation, assuming the water to be all at the same temperature, is the entraining action of the bubbles rising through the water. By many the circulation, in this case, is said to be due to the difference between the density of the column of water in B and the average density of the steam and water in A. That this is not so is shown by the experiment illustrated in Fig. 2, in which air is sent into the inner tube from a horizontal nozzle at C. When the top of the inner tube is above the water level, the rise of level in the inner tube is very small, and when the conditions are as shown, the circulation is comparatively sluggish. If the nozzle, C, however, be turned upward, a much better circulation is induced, but the action in this case is not analogous to that in a boiler.

Another way of regarding the matter is indicated in Fig. 3, where a series of beads are shown attached to a fine wire. When the beads are moved either upward or downward, a circulation is set up, due to their entraining action, exactly as in Fig. 1.

The circulation, therefore, under the conditions shown in Fig. 1 is due solely to entraining action, and not to difference in density of the substance in the two legs. It is due really to the difference in density between the steam and water in the same leg, which sets up a relative flow of the two, and the entraining action of the rising bubbles causes the circulation round the circuit, as well as the local currents which are at the same time induced.

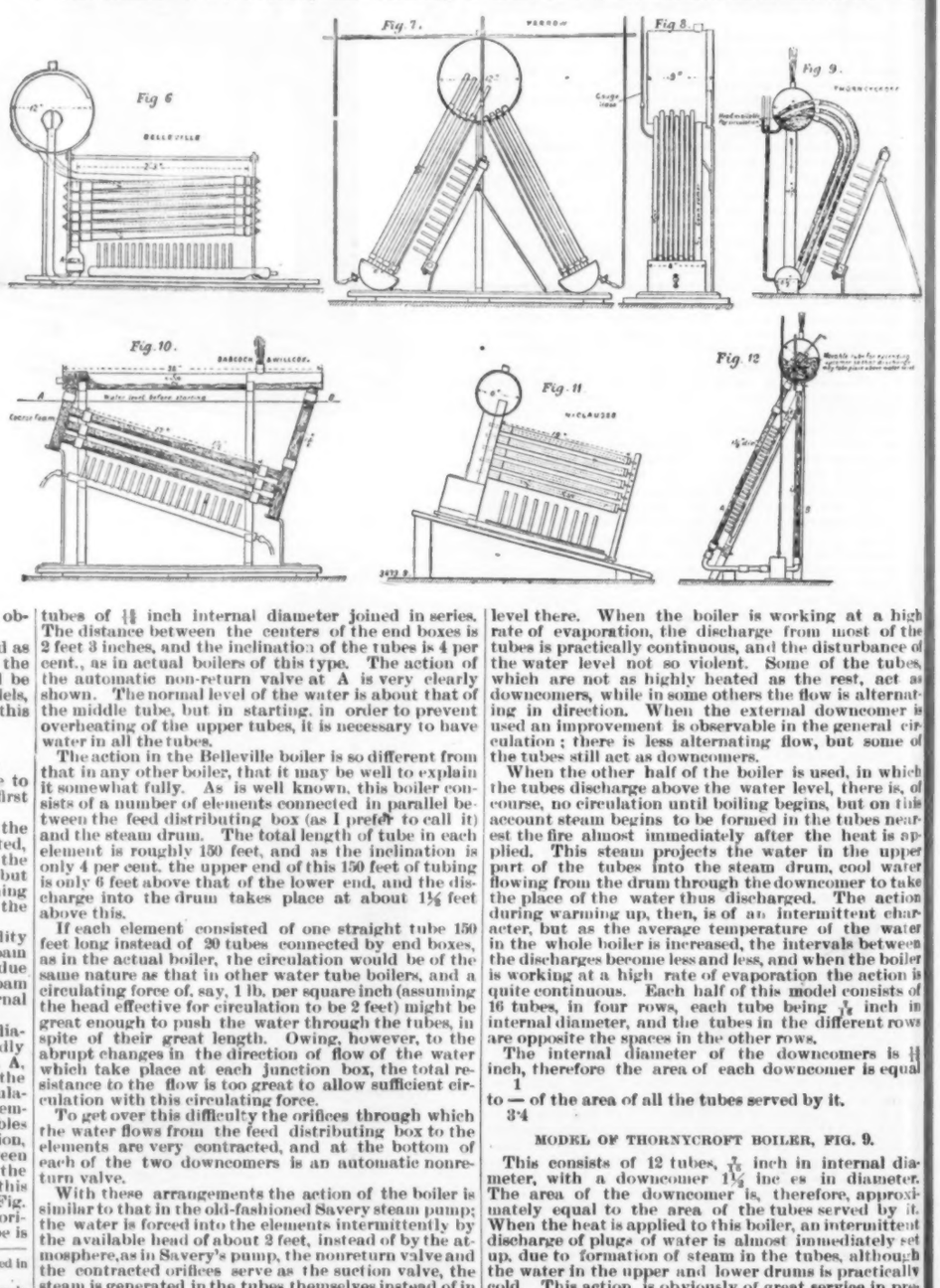
In Fig. 4 steam is being generated more rapidly, and portions of the tube are filled with steam to the complete exclusion of water from these portions. In this case a rapid circulation takes place, on account of the average density of the substance in A being less than that in B. This kind of circulation is by far the most thorough, as none of it is merely local. When working at atmospheric pressure, at rates exceeding about 2 lb. of steam per square foot of heating surface per hour, and with tubes 1¼ in. in diameter, the bubbles do not fill up the whole diameter of the tube, as shown in Fig. 4, but the upper part of the tube becomes filled with foam to the complete exclusion of continuous water, as shown in Figs. 9, 10, and 12.

The circulation in this case is, of course, due to the difference in density between the foam in tube, A, and the corresponding column of water in tube, B, Fig. 12.

The circulation in this case is also vigorous, but as a considerable amount of water falls down from the foam, it is more local, and not as thorough as in the last case.

DESCRIPTION OF MODELS—MODEL OF BELLEVILLE BOILER, FIG. 6.

This consists of two elements, each containing 12 tubes of ⅛ inch internal diameter joined in series. The distance between the centers of the end boxes is 2 feet 3 inches, and the inclination of the tubes is 4 per cent., as in actual boilers of this type. The action of the automatic non-return valve at A is very clearly shown. The normal level of the water is about that of the middle tube, but in starting, in order to prevent overheating of the upper tubes, it is necessary to have water in all the tubes.



The action in the Belleville boiler is so different from that in any other boiler, that it may be well to explain it somewhat fully. As is well known, this boiler consists of a number of elements connected in parallel between the feed distributing box (as I prefer to call it) and the steam drum. The total length of tube in each element is roughly 150 feet, and as the inclination is only 4 per cent. the upper end of this 150 feet of tubing is only 6 feet above that of the lower end, and the discharge into the drum takes place at about 1½ feet above this.

If each element consisted of one straight tube 150 feet long instead of 20 tubes connected by end boxes, as in the actual boiler, the circulation would be of the same nature as that in other water tube boilers, and a circulating force of, say, 1 lb. per square inch (assuming the head effective for circulation to be 2 feet) might be great enough to push the water through the tubes, in spite of their great length. Owing, however, to the abrupt changes in the direction of flow of the water which take place at each junction box, the total resistance to the flow is too great to allow sufficient circulation with this circulating force.

To get over this difficulty the orifices through which the water flows from the feed distributing box to the elements are very contracted, and at the bottom of each of the two downcomers is an automatic nonreturn valve.

With these arrangements the action of the boiler is similar to that in the old-fashioned Savery steam pump; the water is forced into the elements intermittently by the available head of about 2 feet, instead of by the atmosphere, as in Savery's pump, the nonreturn valve and the contracted orifices serve as the suction valve, the steam is generated in the tubes themselves instead of in a separate boiler, and the necessity of a delivery valve is got rid of by discharging it into the steam drum above the water level.

The action, therefore, is intermittent, and some water is driven backward through the contracted orifices during the time plugs of water and steam are being pushed forward into the steam drum. The nonreturn valves prevent water being driven back through the downcomers into the stream drum.

When warming up the action is intermittent, as in all cases where the discharge takes place above the water level, but in this case there is a violent water hammer action, owing to the form of the end boxes, and to steam being generated in several of the tubes at once. Steam generated in the lowest tube pushes the water up into the upper tubes; the steam formed in the upper tubes tries to push this water back again, at the same time that it pushes the water in front of it forward into the upper drum; and on this account when first raising steam the shocks are often very violent.

When properly in action the circulation is very vigorous and thorough, the alternating plugs of water and steam racing each other through the tubes of the element at a very high speed. The amount of water in the tubes is, however, very small, excepting in the lowest tube of each element, which contains much more than any of the others. The circulation in the lowest tube of the element is least thorough, and is partly alternating.

MODEL OF YARROW BOILER, FIGS. 7 AND 8.

It will be observed that one-half of this boiler is arranged with the tubes discharging below the water level, as in actual boilers of this type, and the other half with tubes discharging above the water level. An external downcomer is provided for each half, and a plug is provided so that the downcomer for the drowned tubes may be closed. Either half of the boiler may be used separately.

1. Action with the submerged tubes and with the downcomer shut off.

As soon as the fires are lighted circulation commences, and when boiling first begins, plugs of steam and water are periodically projected into the upper drum, causing a considerable disturbance of the water level there. When the boiler is working at a high rate of evaporation, the discharge from most of the tubes is practically continuous, and the disturbance of the water level not so violent. Some of the tubes, which are not as highly heated as the rest, act as downcomers, while in some others the flow is alternating in direction. When the external downcomer is used an improvement is observable in the general circulation; there is less alternating flow, but some of the tubes still act as downcomers.

When the other half of the boiler is used, in which the tubes discharge above the water level, there is, of course, no circulation until boiling begins, but on this account steam begins to be formed in the tubes nearest the fire almost immediately after the heat is applied. This steam projects the water in the upper part of the tubes into the steam drum, cool water flowing from the drum through the downcomer to take the place of the water thus discharged. The action during warming up, then, is of an intermittent character, but as the average temperature of the water in the whole boiler is increased, the intervals between the discharges become less and less, and when the boiler is working at a high rate of evaporation the action is quite continuous. Each half of this model consists of 16 tubes, in four rows, each tube being ⅛ inch in internal diameter, and the tubes in the different rows are opposite the spaces in the other rows.

The internal diameter of the downcomers is ¼ inch, therefore the area of each downcomer is equal to $\frac{1}{3{\cdot}4}$ of the area of all the tubes served by it.

MODEL OF THORNYCROFT BOILER, FIG. 9.

This consists of 12 tubes, ⅛ inch in internal diameter, with a downcomer 1½ inches in diameter. The area of the downcomer is, therefore, approximately equal to the area of the tubes served by it. When the heat is applied to this boiler, an intermittent discharge of plugs of water is almost immediately set up, due to formation of steam in the tubes, although the water in the upper and lower drums is practically cold. This action is obviously of great service in preventing overheating of the upper portions of the tubes

* Paper read before the Institution of Naval Architects, and published in Engineering.

† From a paper by the author, Institute of Engineers and Shipbuilders in Scotland, January, 1895.

which, before this action commences, do not contain water. In actual boilers of the Daring type, with internal heated downcomers, circulation of water between the drums will be started through the downcomers as soon as the fires are lighted. As before remarked, at high rates of evaporation, even with tubes below ½ inch in diameter, the water and steam do not follow each other in plugs; the upper halves of the tubes are more or less filled with coarse foam, to the complete exclusion of continuous water.

Under these conditions the circulation is wonderfully active, and the water part of the foam is projected in a continuous stream right across the steam drum, as shown, the steam being given off freely, and the water level is only very slightly disturbed.

MODEL OF BABCOCK BOILER, FIG. 10.

This model consists of three tubes, each 1 7/8 inches in internal diameter, and the distance between the centers of the headers is 33 inches. The tubes are inclined at 15° to the horizontal. The circulation in this case is due partly to the entraining action of the bubbles moving through the inclined tubes, partly to the foam filling the upper ends of these tubes, but mainly to the column of foam in the front header. When the level of the water before starting is below that of the bottom of the steam drum, a much smaller drum may be used, without priming taking place, than when the water level is above. When the water level before starting is below the bottom of the steam drum (see Fig. 10, line A B), as soon as the boiler has got into full action, a large amount of water is carried up into the drum along with the steam, and there is a continuous and very rapid flow of water along the bottom of the drum as shown.

MODEL OF NICLAUSSE BOILER, FIG. 11.

In this model there are five tubes, each 1 inch in internal diameter and 18 inches long. The internal tube is ¾ inch in internal diameter, and the inclination is 15°. The action is practically the same as in the Babcock boiler.

EFFECT OF INCLINATION OF TUBE ON VELOCITY OF CIRCULATION.

When each tube draws its supply of water directly from the water drum, and discharges it directly into a steam drum, the greater the inclination of the tubes to the horizontal, the better the circulation. If the tubes draw their supply from, and discharge their steam into, headers, the inclination of the tubes does not greatly affect the circulation, provided it does not fall below about 15°, and provided the currents from the different tubes do not interfere with each other. This is because the circulation in boilers of this type is mainly due to the low density of the foam in the upper part of the front headers. When the inclination is much below 15°, no matter whether the supply of water to the tubes is from a back header or is by means of internal tubes, the circulation is largely local, and the amount of water in the tubes is very small.

When the tubes are only slightly inclined to the horizontal, the only safe way of preventing the water being driven out of them is to use a nonreturn valve, or a very contracted orifice at the lower end of each tube. With a nonreturn valve the tubes may be quite horizontal.

RELATIVE ADVANTAGES OF ABOVE AND BELOW WATER DELIVERY OF STEAM.

When the discharge takes place just at the water level, it seems evident that the velocity of circulation must be a maximum, because the head of water effective for circulation is the same, whether the discharge takes place at or below the water level. In the latter case, however, part of the energy due to this head is expended in giving motion to a considerable body of water in the drum, and the velocity of circulation through the tubes must necessarily be less than when the discharge takes place at the water level. If tubes are carried much above the water level the circulation is, of course, reduced in these tubes. When the discharge takes place above the water level the area of the downcomer is constant under all conditions, but when the discharge is below, this area varies even when external downcomers are used, because the number of tubes acting as downcomers varies with the rate at which steam is being generated.

When the discharge takes place above the water level a much smaller drum may be used for a boiler of a given power, and priming is less likely to take place, because the water level in the drum is only very slightly disturbed, whereas when the discharge takes place below the water level the disturbance is considerable.

Should straight or curved tubes be used?

From what has been said in connection with the action of the boilers when the fires are first lighted, it will be evident that when the discharge is above the water level, some parts of the boiler may be at a very much higher temperature than other parts. From this it seems to follow that, when the discharge is above the water level, provision must be made for free expansion of the tubes, either by bending them, or by leaving the ends free, as in the boilers of Belleville and Niclausse. When the discharge is below the water level, the temperature throughout will never differ much from that of the water, provided the circulation is good, and in this case straight tubes may be used without difficulty.

The author has found, by calculation, that when evaporating at the rate of 20 pounds of steam per square foot of heating surface, the difference in temperature between the inside and outside of the tube is only 2·6° F. for each 1/16 inch in thickness of the tube in the case of steel. The temperature of the metal will, of course, be a few degrees above that of the water, but the more rapid the circulation, the less the difference in temperature between the water and the tube. When working at the above rate, if the water be entirely driven from the heating surface for one second, and the thickness of the tube is ¼ inch, the rise in temperature in that time will be less than 10° F.

Assuming a difference of even 100° F. between the temperature of some of the tubes and that of others, the difference in length in the case of a tube 5 feet long due to this difference in temperature would be only 0·04 inch. If the external diameter of the tube be 1¼ inch, and its thickness ⅛ inch, the force necessary to prevent any increase in length due to this increase in temperature is 3·15 tons. This corresponds to about 8 tons per square inch inch of the metal, which is sufficiently below the limit of elasticity of mild steel to prevent injury to the boiler, even should the above unlikely difference of temperature ever exist between the different tubes of the boiler. By using bent tubes it is possible to obtain a much larger amount of heating surface for a given number of joints, and a given amount of space occupied by the boiler.

RELATIVE ADVANTAGES OF HEATED AND NON-HEATED DOWNCOMERS.

With a given rate of evaporation from a given amount of heating surface, the greatest velocity of circulation will be obtained when all the heat is supplied to the downcomers; but if additional heat be applied to the downcomers, the velocity of circulation will be increased, so long as the amount of heat supplied to the downcomers is insufficient to generate steam with sufficient rapidity to nearly exclude continuous water at some part of the downcomers. In all these models the velocity of circulation is increased by applying a moderate amount of heat to the downcomers.

For this reason it is probable that the circulation in the Thornycroft boilers is more vigorous in those of the Daring type than in those of the Speedy type.

In boilers where the discharge takes place below the water level, as in the Yarrow, Normand, Babcock, D'Allest, etc., even when special external downcomers are provided, some of the tubes most remote from the fire act as downcomers.

In connection with downcomers it is important to note that the entrance to the downcomers ought to be removed as far as possible below the surface of the water in the drum, otherwise the reduction in pressure just inside the upper end of the downcomer may be sufficient to cause steam to be generated in it at that part. The steam thus formed would, of course, be condensed on its way down by the increased pressure. This action is indicated in Fig. 5. In connection with internal heated downcomers, insufficient attention has, I believe, been paid to the advantages of a few tubes of larger diameter being placed in the midst of tubes of smaller diameter.

DETERMINATION OF $\frac{\text{WEIGHT OF CIRCULATING WATER}}{\text{WEIGHT OF FEED WATER}}$

When considering the best method to be adopted in order to determine this ratio, the author first thought that the best arrangement would be by means of a circular thin lipped orifice, of known dimensions, placed near the top of the downcomers, but it soon became evident that although this method might be adopted for cases where the discharge takes place above the water level, it could not be used in cases where the discharge is below the water level, because in these cases some of the tubes act as downcomers, no matter how large the external downcomer may be.

In order to get over this difficulty the author used the model illustrated in Fig. 12, which consists of only one upcomer and one downcomer. By means of the loose glass tube shown attached to the brass rod in the steam drum, the discharge may be made to take place above the water level. After trying various methods for measuring the circulation, it was found that the simple water column pressure gage was the most convenient, and of sufficient accuracy for present purposes.

In Fig. 12 this is shown attached to the top of the lower drum, another column being attached to the bottom of the steam drum as shown. The head available for circulation is the difference in the heights of these two columns, and the velocity of the water in the downcomers is proportional to the square root of this difference of levels. In connection with this, it is important to remember that this difference of level may be increased, either by an increase in the velocity of circulation, or by an increase in the resistance to the flow of the water from the upper to the lower drum.

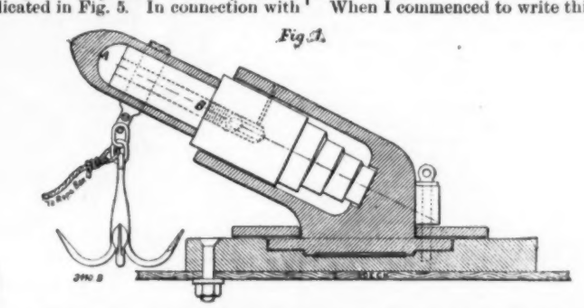
The following results were obtained with this apparatus when working at atmospheric pressure and evaporating 13 pounds of water per hour, the evaporation per hour per square foot of heating surface actually subjected to flame being 10·8 pounds:

Area of Downcomer.	Depression of Water Column.		Weight of Circulating Water / Weight of Feed Water		Remarks.
	Discharge above.	Discharge below.	Discharge above.	Discharge below.	
sq. in.	in.	in.	lb.	lb.	
0·087	21	18	40	37	
0·329	8¼	7¼	147	138	
0·994	3¼	3¼	242	242	The difference between these two readings was so small that it could not be read.

By means of the glass tube extension to the upcomer, it was possible to take the readings of the columns when discharging above, and when discharging below the water level, immediately after one another.

To determine the weight of circulating water in each case, separate tests were made for each size of downcomer with the upcomer disconnected, and the outlet from the bottom drum contracted to give a suitable difference of level between the columns. Water at about 200° F. was then siphoned into the upper drum, and the weight of water flowing down the downcomer per minute, and the difference of level of the column being obtained, it was possible to determine, with considerable accuracy, the weight of circulating water under the actual conditions of working as given in the above table.

When I commenced to write this paper my intention was merely to describe the action in the various models shown, but as practically the whole of the problems connected with the design of water tube boilers depend on the nature and amount of circulation under various conditions, I was gradually led into a discussion of some of the most important problems which are affected by the circulation.



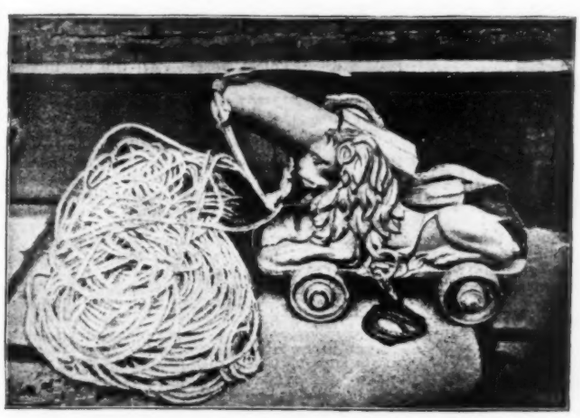


FIG. 2.—GARWOOD'S LINE THROWING GUN.

GARWOOD'S LINE THROWING GUN.

AMONG the inventions submitted to the committee appointed to adjudicate in connection with the prize offered by the Illustrated Daily Graphic for the best apparatus for throwing a line from a stranded ship to the shore, was the line throwing gun of Mr. Alfred E. Garwood, of Newport, Mon., which we illustrate on this page. The committee, consisting of Rear-Admiral G. H. Seymour, Captain G. Vyvyan, and Captain H. Wyatt, made special reference to this gun in the paragraph alloted to honorable mention, as follows: "Among guns we must also refer to that of Mr. Garwood, of Newport, Mon., whose ingenious model on a small scale we have seen carry a projectile and line with great accuracy of aim and surprising length of range." These remarks referred to a model, but since they were made the 2 in. gun shown in Fig. 1 has been constructed; it carries a shell weighing, with three grapnel irons, 35 lb. (see Fig. 2), or an ordinary boat grapnel hung from the projectile, and a rope of three strand manila, ¾ in. in circumference, weighing 20 lb. Trials made in a field, near the Pontymister Steel Works Foundry, where the gun was constructed, gave the following results:

Round.	Powder. Oz.	Range. Yards.
1	3	90
2	4	130
3	6	175
1a	3	89
2a	4	135
3a	6	196
4	8	250

The construction of the gun is shown in Fig. 1, which illustrates a design fitted to be bolted to a ship's deck or bridge. In this design the grapnel is hung from the projectile, and is not attached to its nose, as in Fig. 2. The projectile, it will be noted, fits around and slips over the outside of the gun, which is of steel, with a bore of 2 in., mounted in a revolving socket table, which can be swiveled to point in any direction. The breech or butt of the gun has a certain amount of end play in the socket, and recoils on the strong coiled spring shown, the recoil being controlled by two studs passing through slots in the wall of the socket. The charge of powder is introduced into the barrel of the gun in the usual manner; a tight fitting disk or wad is then inserted to keep the charge home, leaving about 8 in. of air space in the bore. The projectile, with the grapnel and rope attached, is well greased on the inside and slipped on to the gun, thus completely sealing up the air in the gun between the muzzle and the charge. The firing is effected by the ordinary tube fuse and lanyard.

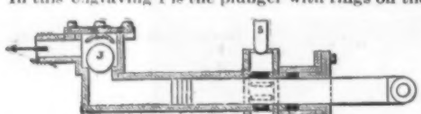
The carriage represented in Fig. 2, with one of the guns mounted ready for service, is one of the ordinary distress signal gun carriages in use in the Swedish mercantile marine, and thus answers both purposes. The rope shown in front of the gun (Fig. 2) is the one that was used in carrying out the experiments, and would be coiled in a box for the purpose precisely similar to the rope boxes now supplied to the coast-guard rocket apparatus. The motion of the projectile with the rope attached can be followed by the eye, and hence it is quite easy to avoid being hit by it, if it should be thrown from ship to shore or ship to ship. The rope is attached to the underside of the projectile, and is well out of the line of fire, and therefore cannot be burned.

SOME HORSELESS CARRIAGES.

IN 1866 Mr. H. Percy Holt designed and built a horseless carriage herewith illustrated, which he subsequently sold to Mr. S. G. Rhodes, who had previously been making a carriage which we now also illustrate. Mr. Rhodes of this carriage says it was one he "began to build in 1863," and that, "when completed, it did some very fair running. At first it was direct action on four wheels, and not satisfactory, but when altered to the form as shown in the drawing, it ran splendidly on any road and over new metal."

Mr. Rhodes made some alterations in it, including the lap of the valves and the position of the eccentrics. And writing from the works of Messrs. Rhodes Brothers, mechanical and electrical engineers, Hanover Works, Leeds, Mr. Rhodes says: "The photograph shows myself and twin sons on Holt's carriage a quarter of a century ago; Rhodes Brothers are the same twins." Referring to the pump mentioned in our notice of Mr. Holt's carriage, Mr. Rhodes sends a sketch, from which the annexed engraving is made, saying that he had previously used it on his own carriage.

In this engraving 1 is the plunger with rings on the



FEED PUMP OF HOLT'S STEAM CARRIAGE.

end; 2, a cage round pump barrel over the slots with water inlet pipe 5; 3, ball delivery valve; and 4, packing, which had not any pressure to withstand.

Of this pump he says: "This pump, when running quickly, would lift water in a state of ebullition 3 ft. and force into boiler at 150 square feet. The plunger bared the slots at the end of the stroke, where it was moving slowly and coming to a stop; the pump never failed."

Of his own carriage Mr. Rhodes sends the drawings, from which it appears that the two cylinders are connected to one crank shaft with cranks at right angles, and with a chain pinion on each end driving the road wheels, to which chain wheels are attached to the spokes. Both wheels are equally driven, no arrangement being provided for turning corners. Subsequently the crank shaft was separated into two lengths, and each engine ran independently, thus allowing for corner turning. The frame was made of 4 in. by ¼ in. flat iron, with a 1¼ in. angle riveted to the top edge, and was carried on three wheels, two driving wheels 5 ft. diameter by 3 in. face, and one steering wheel 3 ft. diameter by 3 in. face, strongly made of oak, and steel tired; between the driving axle and frame were long leaf springs, connected with radius rods to the engine crank shaft; the front wheel was carried by a fork fitted with sliding bearings supported on spiral springs and connected by links to the steering handle.

The boiler was 2 ft. in diameter by 3 ft. 6 in. high, and had seventeen Field tubes and thirty-six flue tubes into smoke box, and worked at a pressure of 150 lb. per square inch. The engines were placed one on each side of the boiler, and had cylinders 3⅛ in. bore by 9 in. stroke, and geared 5 to 1 to the driving wheels by means of pitch chain.

The feed pump, which was worked from one of the engine crossheads, was specially designed, and probably the first of its kind, made to lift and force boiling water, and had only one valve. A feed pump made to this design was afterward fitted to Mr. Holt's steam carriage.

Part of the exhaust steam was turned into the water tank to heat the feed, the remainder into the chimney, and rendered noiseless by means of a double cone blast nozzle. All the machinery was completely inclosed, and the carriage ran successfully for many years without any serious accident or complaint, and would make from twelve to fourteen miles per hour with ease.

The vehicle made in 1869, by Messrs. Catley & Ayres, was exhibited at the Yorkshire Agricultural Society's meeting held at York in 1871, and has only been briefly referred to in any publication.

The accompanying engraving from a photograph shows the machinery, with the carriage body removed and a side view of the same. The frame is made of bar iron 3½ in. deep and ⅝ in. thick, bent to the shape required, and the ends welded together. About the middle of the frame there are two pieces of tee iron and there are transverse bars in other parts for stiffening the structure. The horn plates for the axle boxes and the deeper plate for the cylinders are welded in the frame.

The carriage is propelled by a pair of horizontal engines driving a short crank shaft, with the two cranks placed at right angles to each other. The cylinders are 2⅝ in. diameter and 5¾ in. stroke; the piston beads are forged with the rods. The pistons have grooves cut in them for two steel rings; each ring is ⅛ in. wide and ⅛ in. thick. Wrought iron is used for the slide bars and crossheads, so as to reduce the weight; the wearing surfaces of these parts are case hardened. Eccentrics are keyed to the crank shaft for actuating the slide valves; the eccentrics are shown with the straps and eccentric rods removed. No link motion is used, as it was not considered necessary, as the carriage, being only 8½ ft. long, could be turned round with facility in a small space. The omission of link motion reduces the number of wearing parts, which is an advantage. A wrought iron flange plate is riveted in between the side plates on which the crank shaft bearings are carried. This plate also acts as a stay to the side plates. A small spur pinion is keyed on the crank shaft, which gears into a wheel on the driving axle; the ratios of the wheels are 3 to 1. There is only one traveling speed, and the constructor does not consider this a disadvantage, as the speed could be varied by varying the speed of the engines to suit most of the roads to be traversed. The carriage has been run at the rate of twenty miles an hour, and has traveled up gradients of 1 in 20.

The hind axle is 2 in. in diameter; the bearings are made of cast iron sliding in the iron plates; the weight of the hind part of the carriage is passed to these axle blocks through long plate springs, as shown in the engravings. As the crank shaft and main axle are on the same horizontal center line, the up and down motion of the axle caused by the action of the springs will not affect the spur wheels very much, if the movement is not excessive. An arrangement like this has been used on one maker's traction engines for many years without any serious inconvenience.

YARROW & HILDITCH'S STEAM CARRIAGE, 1862.

The driving wheels are 3 ft. 6 in. diameter; the twenty spokes in each wheel are made of ½ in. round iron, with collars forged on the outer ends faced in the lathe, and chased on the ends beyond the collars, as shown in Fig. 3. The ends of the spokes are screwed into a 2 in. by ⅛ in. wrought iron hoop, and into the ash tire also; the fellies are doweled together with iron pins. At this stage the wheels were sent into the foundry to have the bosses cast on, afterward they were bored and faced in a lathe; the wood tires were also turned on the sides and on the outer edge. The outer hoop was next shrunk on; it is made of 2 in. by ⅛ in. iron. It will be seen that the inside hoop, the wood tire, and outside hoop are riveted together. This makes a light and satisfactory wheel. One of the driving wheels is keyed to the axle, the other runs loose so as to facilitate turning. The front wheel is 2 ft. in diameter, and is made in the same manner as the hind wheels; the leading wheel runs in a fork, the spindle of which turns in a double guide of light wrought iron; the guide is riveted to the fore part of the frame, as shown in the illustrations. Four arms are welded on each side of the steerage fork; these are secured to a ring, or turn table, which encircles the wheel. This ring turns in four small cast iron guides; each guide is mounted on a spiral spring,

HOLT'S STEAM CARRIAGE, 1867.

CATLEY & AYRES' STEAM WAGONETTE, 1863–67.

and held in position by the front end of the frame. The weight of the fore end of the wagonette is supported by these springs. The steerage works well; the carriage can be easily guided with one hand on the lever. A feed pump is fitted, but not shown in the drawing. There are two feed water tanks, one is placed in the front, the other at the side under the seat; they are connected by a pipe beneath the floor. Under the opposite seat is a locker for canvas buckets and small tools. There are places for coal or coke.

Two of the floor boards are hinged on to the iron cross stays of the frame; each board is 7 in. wide, and placed directly over the engine. The engine can be readily examined by means of these doors if needful, but the machinery is of such a simple character that it requires little or no attention beyond the lubrication of the working parts. The driving wheels are fitted with lever hand brakes, as shown.

The boiler is of the vertical fire tube type, constructed of Lowmoor iron plates. It is 3 ft. high and 17½ in. external diameter. The shell plates are ⅜ in. thick and the tube plates are ⅞ in. thick. A spiral tube superheater is fitted in the smoke box made of 1¼ in. piping; the steam passes through this coil on its way to the engine cylinders. The iron smoke box and chimney are covered with a polished copper casing. To prevent the radiation of heat, the boiler is coated with a thickness of non-conducting material, and polished mahogany lagging outside. Mr. Catley tested the boiler with water up to 400 lb. pressure per square inch. The working pressure is 150 lb. By using good coal very little smoke was made, but coke could be used if required. The boiler supplied dry steam, and the engines are set to work with an early cut-off. The passage of the exhaust steam into the chimney base causes very little noise, and therefore was not suppressed. Twenty gallons of water and about 2 cwt. of fuel can be carried.

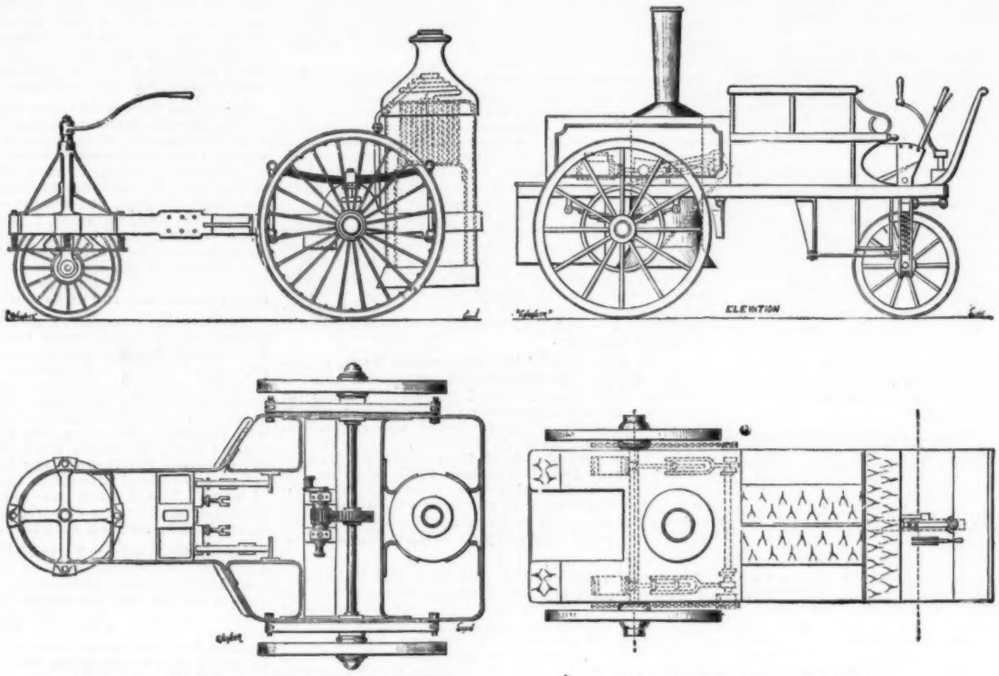
The engine made many journeys during three years, carrying four passengers for eight or ten miles round York; the speed could be increased up to about twenty miles an hour on good, level roads, and slower rates of speed were attained on gradients. Little noise is made by the carriage when traveling; there is no vibration whatever, and Mr. Catley says, "The horses they met during their numerous journeys took no notice of it."

An important feature of this steam wagonette is its very moderate weight. When the boiler, tanks, and bunkers are full, ready for a run, the total weight was only 19 cwt. Among the objections urged against the steam engine for carriage propulsion the supposed weight is always dwelt upon. But this example appears to show that with careful designing a steam carriage of substantial construction, and well adapted for hard work, need not necessarily be as heavy as many that have been built. The reduction in the weight is secured by the use of light bars of wrought iron for the frame. No cast iron is employed except where it is absolutely necessary, and when it is used the parts are made as small as possible. The driving gear is simple. The use of one speed cuts down the number of parts, and although in respect of the driving of only one wheel, and in small details, improvements could easily be now made, it will be admitted that Mr. Catley's carriage presents several features of interest.

We now publish an illustration, made from a photograph placed at our disposal by Mr. A. F. Yarrow, of Yarrow & Hilditch's steam carriage shown at the Exhibition of 1862, and the following description is from a paper read by Mr. Yarrow before the Society of Engineers:

"It is made to carry thirteen persons, including a steerer and a stoker. The steerer sits in the center of the front seat, having one passenger on each side. Back to back with them are seats for three others, and for six more—three on each side—facing each other. By this mode of arranging the seats, it can conveniently be covered in, with a door on one or each side for entrance. The stoker is placed in the tender behind. The boiler is of the ordinary upright tubular type, the outside shell being steel. It is 2 ft. diameter and 3 ft. 9 in. high; it has 40 sq. ft. of heating surface, and a fire grate 21 in. in diameter. It is fitted with a perforated steam pipe round the top to reduce the chance of priming. The main framing of the carriage is ash, 4½ in. deep, lined with edge plates ¼ in. thick. To the outsides are bolted two iron foundation plates for carrying the cylinders, etc. On the inside of the framing are the driving wheels, which are 3 ft. diameter; they have a cast iron boss similar to Crosskill's, and are both keyed on the main driving axle; on the outside of these wheels come the bearings which carry the springs; beyond these are fixed the cranks, to which one end of the connecting rod is attached. The advantages claimed for thus arranging the parts are: 'That the gage of the hind wheels, being considerably reduced, does not necessitate throwing the inner one out of gear when turning curves; and, secondly, that direct action is obtained without having the axle cranked, which past experience has shown to be highly objectionable, as the continuous jolting very soon breaks it.'

"In order to keep the axle in its right position, a link is employed in preference to axle box guides, as, by its use, far less friction is caused, and the distance between the shaft and cylinder is maintained precisely the same, and the action of the valves remains unaffected by the vertical play of the springs. One end of the link is connected to the axle bearings and the other to a provision on the foundation plate. The working parts are entirely boxed in to protect them from dust and grit. The cylinders are 5 in. in diameter and 9 in. stroke. When fully loaded the weight is 2½ tons; about 40 cwt. is carried on the bind wheels and 10 cwt. on the front ones."



CATLEY & AYRES' STEAM WAGONETTE. RHODES' STEAM CARRIAGE.

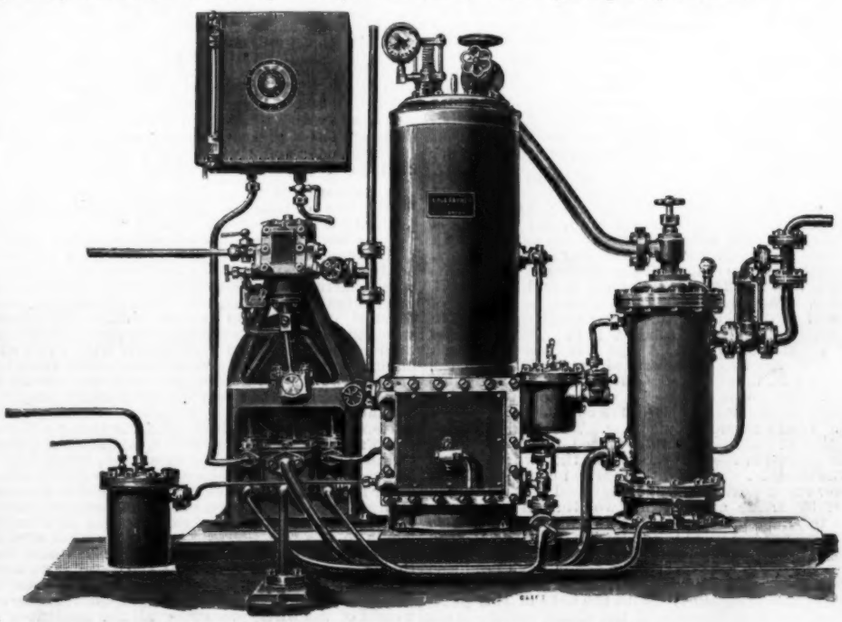
At the newly put up briquette factory in connection with the Frohliche Morgensonne Colliery, near Wattenscheid, Westphalia, the slack is tipped into a storing tower, from which it is led by a creeper to the point where its mixture with ground pitch is effected. The mixture is then led by creeper and elevator to a distributing hopper and then by traveling bands, charging elevator and conveyors into two directly fired heating ovens. After the mixture is thoroughly warmed, it is led by creepers to the Couffinhall presses, which produce briquettes weighing 3 and 5 kilog. (6¼ and 11 pounds), the three presses turning out 175 tons of briquettes in a day of ten hours. The larger briquettes are chiefly used for firing marine boilers and the smaller for those of locomotives, says the Engineering and Mining Journal. For the requirements of the coal preparing and briquette making plant there are four steam engines, one for the dry separation, one for the washing, one for the briquette factory and the fourth for leading away the coal from the drying receptacles to the briquette works; and, owing to this arrangement, work can be carried on in each department independently of the others.

NEW FRESH WATER DISTILLING APPARATUS.

Of late years great strides have been made in supplying pure water for marine boilers. Caird & Rayner, London, E., have recently turned their attention to producing an improved form of fresh water distilling apparatus for both land and marine purposes.

The illustration shows a complete distilling apparatus, with evaporator, condenser and pumps. These apparatuses have been supplied to the British and foreign admiralties, and to the principal steamship companies. They are also being extensively adopted in foreign countries for use on land where pure drinking water is required. For this purpose they can be made either fixed or mounted on wheels so as to be portable.

We are indebted to the Steamship, of Leith, Scotland, for the engraving and particulars.



NEW FRESH WATER DISTILLING APPARATUS.

ENGINEERING NOTES.

A French company is going to work the coal deposits in the Faroe Islands and to build a pier at deep water in the harbor of Trangisdaag.

Russia is pushing the construction of the Tiflis-Kars Railway as fast as possible, and will probably have it completed by August next. It will enable her to carry an army from the Caucasus to the doors of Turkish Armenia. The line is 190 miles long and is already built as far as Alexandropol, fifty miles from Kars.

After 1899 Sebastopol will no longer be a commercial port, but the new port of Theodosia, just completed by the Russian government, will take its place. It has a jetty 2,044 feet long, and the quays within the port are 3,900 feet long, with 24 feet of water. The port has a superficial area of 2,500,000 square feet, of which over 500,000 are paved.

Engineers know that the strength of wrought iron at 60° Fah. and at 320° Fah. is practically constant, says Engineering Mechanics, while at 30° Fah. the strength was greater. Prof. Dewar's recent researches show that the strength of iron wire immersed in liquid air at a temperature of —320° Fah. is raised from 34 tons to 62 tons per square inch.

The moving sidewalk at the Columbian Exposition is to have its counterpart at the Berlin Industrial Exposition next summer, where a "stufenbahn" or "step railway" is now being built. A number of platforms running alongside of each other are propelled by electricity, which is furnished to motors by underground wires. The different platforms run at different speeds. The first advances at the rate of about three feet per second, while the fourth advances at the rate of twelve feet per second. The last platform is provided with a double seat and is roofed over, making travel on this road pleasant. This railway will perform the same service as the Intramural Railway did in Chicago. The great advantage of the means of communication of this kind is that it enables passengers to begin the trip at any moment.

An unboxed flywheel acts as a centrifugal air pump or fan. Air flows into the wheel at the center and is thrown off at the rim. Power is consumed in imparting motion to this air, just as it would be in pumping it by any other means. When the valve is closed on a centrifugal pump the consumption of power ceases beyond that necessary to revolve the shaft in its bearings and overcome the friction of the fluid which has been shut in. A close casing about the wheel might be expected to reduce this fan action and thus reduce the work of turning the wheel. On the other hand, the fan action may be usefully applied. We know of a case where the air is taken from the outer edge of a flywheel casing and conducted through a coil heater into the mill, the excess of pressure at the rim casing being sufficient for the purpose.—Electrical Review.

The fact is well known that a mixture of tungsten with steel imparts to the latter so great a degree of hardness that it readily scratches glass and quartz. Recent investigations have thrown light upon this somewhat remarkable phenomenon—that is, a definitely crystallized compound of iron and tungsten is announced as having lately been discovered, the crystals being so hard as to be capable of scratching topaz. Tungsten is a brittle white metal, almost as heavy as gold, and the crystals formed by its combination with iron, in the proportion of one atom of iron to two of tungsten, are silver gray and very brilliant. The conclusion arrived at by experts in this line is that, on tungsten being alloyed with steel, some of the compound just described is formed in the mass, thereby producing the remarkable increase in the hardness of steel and adding to its usefulness.

The number of small railroad lines in the South which have been built within recent years is remarkably large. Their owners are principally lumber and mining companies who have constructed them originally for carrying timber, ore, etc., to mills and furnaces or to some larger system to which they usually connect. The Manufacturers' Record has been compiling a summary of these private railroad lines in the Southern States, which shows that about $11,500,000 capital is now invested in them, and that the mileage is very extensive. In North Carolina alone nearly 300 miles of such lines have been built. The longest private road is in Southeastern Texas. It is a tram road 75 miles in extent. In Kentucky, North Carolina, Texas and Georgia the investment of capital in these roads has exceeded $1,000,000 in each case. The figures given by the Manufacturers' Record show that the greater number have been very profitable, one line in North Carolina earning 10 per cent. in annual dividends, while another company has built 15 miles of extension from the profits of 25 miles in operation.

When the Compagnie des Mines d'Anzin were about to sink two shafts near Vicq, quicksand was met with about 3 ft. below the surface; 20 ft. lower followed a tertiary argillaceous sand, and under it a loose chalk with water, which threatened to break through the tertiary sand. Freezing was, therefore, resorted to, says the Railway Review. The shafts were to be 5 and 3·65 meters (about 16 and 12 ft.) in diameter. They were each surrounded by a ring of boreholes; the ring of the larger shaft was 20 ft. in diameter, that of the smaller, 17 ft. The boreholes had a width of 10·2 in. A pipe was inserted in each borehole, and two concentric pipes, the inner 1·2, the outer 4·3 in. in width, were fitted into each of these pipes. The concentric pipes were joined to a ring above, communicating with the cold brine produced by a Linde ammonia machine. The cold liquid, a solution of calcium chloride, flowed down the inner pipe and up in the space between the two to return to the cisterns. The plant comprised a twin 200 horse power engine, driving by its flywheel and belting a fourfold Linde compressor, two Burton pumps to cool the ammonia and two more pumps of the same type to keep the brine in circulation, which was cooled down to —4° Fah. About 67 cu. ft. of brine circulated every minute; the plant might have produced 10,000 lb. of ice an hour. Over eight miles of pipes were needed altogether. With the help of this plant the ground was frozen, and the shafts pushed lower and lower. They are now over 160 ft. deep.

ELECTRICAL NOTES.

Stockholm has a telephone for every twenty-six inhabitants. There are now 28,500 miles of telephone lines in Sweden.

The result of some experiments of the loss of light due to the use of frosted globes for arc lamps shows the absorption to be remarkably small, the loss being only 11 per cent.

The City and South London Railway has just completed its first five years of existence. During this time it has carried 30,441,609 passengers. It now finds itself unable to handle the increased traffic at night and morning.

Como, the native town of Alessandro Volta, is going to celebrate the hundredth anniversary of the invention of the voltaic cell by an electrical congress and an electrical industrial exhibition. A square is already adorned by a statue of him.

The experiment of heating a theater by electricity has been tried at the London Vaudeville. Storage batteries were employed connected with electric radiators. The great advantage of this method of heating theaters is that it insures safety against fire, if the wiring is done properly, and it is valuable on account of the uniformity with which the heat is distributed. It is said that the expense was less than 70 cents per hour.

The Western Electrician, of Chicago, enumerates some of M. A. D'Arsonval's results in measuring the electrical power of the so-called torpedo ray. In one case he found the discharge to be 11 amperes at a pressure of 25 volts. By connecting the fish with two plates of tin, one on the upper side and the other on the lower, he succeeded in lighting a small lamp several times. The upper surface is positive and the under surface negative.

In a recent number of the Engineering News, attention was called to the effects on the magnetic needles of surveying instruments, caused by carrying them on trolley cars, as the magnetism of the motors affects that of the needle, either reversing the magnetism completely or changing its intensity. It is recommended that surveyors keep their instruments as far as possible away from the motors. It is said that the United States Geological Survey is having trouble in determining the magnetic variation in Philadelphia, on account of pipes and other conductors in the earth beneath the city carrying so many electric currents.

The annual report of the American Bell Telephone Company gives some interesting particulars of the telephone in the United States. The total number of metallic circuit stations on January 1 was 97,747, a gain of 40,067 for the year. In the long distance companies' system there are in operation 5,804 miles of pole line and cables and 90,251 miles of wire, which serve 149 offices. The principal cities and towns through most of the States east of the Mississippi are now connected by telephone, and a conversation can now be held over distances of 1,500 miles, which is twice as great as the length of any telephone line outside of the United States. Within the last five years 130,000 miles of telephone wire have been placed under ground.

The electrical production of metallic mirrors forms the subject of a patent taken out by Herr Hans Boas, of Kiel, says Electric Power. The method is based upon the by no means new observation that various metals —those of high specific gravity, therefore particularly the precious metals—inclosed as electrodes in a Geissler tube or other vacuum tube, upon the passage of an electric discharge, for example, of an induction coil or of a high pressure direct or alternating current, in so far as they form the cathodes, are dissipated and deposited on the walls of the vessel. If the tube or the holder be filled with an oxygen-free gas of low pressure, say with hydrogen, the metal is compactly deposited on the sides of the vessel, producing the mirror of fine quality.

In the short space of one year the number of electric railways in Europe has increased from 43 to 70, and the aggregate length of the lines from 189 to 434 miles, says the Electric Railway Gazette. The total capacity of central stations has grown in the same time from 10,650 to 18 150 kilowatts, and the number of motor cars from 538 to 1,286. Germany leads the list with 227 miles of line, France comes next with 59·7 miles, England with 42·6 miles, Austria-Hungary with 27·8 miles, Switzerland with 23 miles, Belgium with 13·4 miles, Italy with 11·7 miles. Spain with 8·7 miles, Russia and Servia with 6·2 miles each, Sweden and Norway with 4 miles, and Roumania with 33 miles. Germany has 22 separate lines in service, England has 13, France 11, and Switzerland 8. Out of 70 lines, 55 use the trolley system of overhead conductors.

In Germany for many years past bronze wire has been in use for telephone lines, on account of its conductivity being superior to that of iron or steel wires. Besides bronze wires covered with copper, a number of German makers have also brought out numerous double metal wires, under the name of compound wire, bimetallic wire, double metal wire, double bronze wire, patent bronze wire, etc. These wires have a core of steel or aluminum bronze, with a high tensile strength, and are covered with copper or bronze of a high conductivity, and experiments with these wires having been made with a view to comparing them with bronze wire for telephonic purposes, the results are claimed to show that they have important properties available in that way. It is stated, for example, that a telephone line with a bimetallic conductor will work much more perfectly than with a conductor of a single metal, such as copper; less insulation, too, is said to be needed for such a conductor than for copper or any other material, and hence such wires laid on the earth without special insulation permit a telephonic connection to a much greater distance. The final experiments in this line, however, are to the effect that the double metal wires are really no more valuable than the pure copper wire, but that the distance to which telephonic transmission by bare wires laid upon the earth is possible depends mainly upon the size and weight of the wires, presuming all the conditions are similar.

MISCELLANEOUS NOTES.

The authorities of St. Petersburg are said to be contemplating the admission of none but rubber tired vehicles on certain streets, as wheels equipped with ordinary tires splash so badly.

In Great Britain and Ireland, from 1889 to 1893 inclusive, some 4,526 strikes occurred, says the Manufacturer. They affected 1,852,103 persons. The successful strikes affected 44·5 per cent. of this total number; the partially successful, 33·9 per cent.; and the unsuccessful, 21·6 per cent.

The State censuses taken last year indicate that the East is growing more rapidly than the West, says the Keystone. In the five years since 1890, Massachusetts gained in population 262,000, or 11·7 per cent. The gain of New Jersey was 313,000, or 15·7 per cent. Iowa's corresponding gain was 146,000, or 7·6 per cent. Kansas reports a loss since 1890, and Oregon's increase in five years is not quite 8 per cent. In 1790 the center of population lay in Baltimore; in 1890 it lay in Indianapolis, 500 miles westward.

In a recent lecture before a teachers' association of Turin, says the Medical Record, Prof. Lombroso dwelt upon the practical advantages of a knowledge of the science of criminal anthropology to those who have to do with the training of the young. The inclinations of the child, he said, are almost the same as those of the adult criminal, but usually disappear as age advances. In some instances, however, these characteristics continue and become more and more marked. In these cases there are associated physical peculiarities, and it is in the detection and pointing out of these possible criminals of the future that the speaker believed the teacher can do so much truly useful work.

A statistician compiled the following figures, showing the cost of nourishment for the various nations: The average Englishman consumes $250 worth of food per year; Germans and Austrians, $216 worth; Frenchmen, $212; Italians, $110, and the Russians only $96 worth of eatables per year. In the consumption of meat the English-speaking nations are also in the lead, with 128 pounds of meat a year per capita of the population; the Frenchman using 95 pounds; Austrians, 79; Germans, 72; Italians, 52; Russians, 50. The consumption of bread is reversed being compared to that of meat. The English use 410 pounds a year; the Frenchman, 595; the Austrians, 605; Germans, 630; Spanish, 640; Italians, 660; the Russians, 725.

A somewhat heroic French scientist, says the New York Tribune, is credited with having boldly declared that a large number of nervous maladies from which girls at the present day suffer are to be attributed to playing the piano. Statistics show, according to this authority, that of 1,000 girls who study this instrument before the age of twelve, no less than 600 suffer from this class of disorders, while of those who do not begin till later there are only some 200 per 1,000, and only 100 per 1,000 among those who have never worked it; the violin is also proved to be equally injurious. The remedy suggested is that children should not be permitted to study either instrument before the age of sixteen at least, or in case of delicate constitutions, not till a still later age.

A dispatch from Berlin says: "Herr Krupp, the gunmaker, is the richest Prussian subject. He is taxed on an income of 7,135,000 marks ($1,700,100). This is nearly half the crown donation which the Emperor gets as King of Prussia. Baron Rothschild is classed as the second richest subject, with an income of 5,848,000 marks ($1,400,000). Count Hutten-Czapskia, captain of the Fourteenth Hussars, is the third richest Prussian subject, with an income of 3,085,000 marks, upon which he pays a tax of 123,400 marks. Only seven persons had incomes over 2,000,000 marks ($476,000), and only thirteen persons had incomes between 1,000,000 and 2,000,000 marks, compared with eighteen such fortunates in 1895. Those liable to an income tax by reason of having incomes of over 900 marks comprise three-tenths of the population."

According to the discoveries of Zsigmondi, says the Pottery Gazette, it is possible, says a contemporary, by the addition of small quantities of protoxide of iron, to produce glass which possesses sufficient transmission for rays of light, while allowing the passage of a small quantity of heat only. Such glass is especially adapted to the manufacture of protective shades against radiating heat, which would be of great value to many industries as well as to the single lighting bodies. Of similar importance are those discoveries for the production of good window glass. As is well known, window glass may show a rather strong green coloring without its being noticed much or disagreeably when put in the windows. By using glass containing protoxide of iron it would, therefore, be possible to detain to the greater extent the radiant heat produced in the interior of the room, as well as the caloric rays of the sun falling from the outside upon the windows. This, however, already happens to a very considerable extent with the everyday glass of commerce.

The various attempts which have been made to obtain an accurate imitation of wood in glass have now been successful. The process by which the effect is produced is quite simple, says the Upholsterer, and consists in clouding a sheet of plain or ground glass on the reverse side with a liquid dye of a proper color to represent any desired wood. The dye is applied by means of a sponge, so manipulated as to bring out the semblance of the grain of the wood on the glass surface. A badger brush is used to soften the shading, and the glass is then covered with varnish; this leaves the grain clear, distinct and fast, without the necessity of using any gelatinous substance, which would render it liable to shrink into crinkles, thus spoiling the effect. To complete the operation the glass is heated slightly, and the various shades required for the particular wood are caused to spread over it by means of a syringe, the merging of the shadings into each other being prevented by slightly heating the glass. The whole is made of a semitransparent aspect by means of another coat of varnish, which also preserves and protects the dyes, and with this final dealing the exterior or surface is made to present the appearance of a highly polished wood finish.

SELECTED FORMULÆ.

Magic Cloth and Glove Cleaner.—This is intended for silk or dress goods, gloves, ribbons, etc. It will not stain nor discolor.

Gasoline	1 gal.
Chloroform	1 oz.
Bisulphide of carbon	1 "
Essential oil of almonds	5 drops.
Oil of bergamot	1 drachm
Oil of cloves	5 drops.

Mix them. To be applied with a sponge or soft cloth. Gloves are best cleaned on the hand. This preparation should not be made or used at night or in a room where there is a fire, as it is very inflammable.—The Formulary.

Sheep Dip.—

1. Creolin-Pearson	1	lb.
Water	14	gal.
2. Soft soap	½	"
Water	15	"
Crude carbolic acid	1	pint.

Dissolve the soap in the water with the aid of gentle heat (140° F.), and incorporate the carbolic acid; then cool down to 110° F. and dip the sheep. For the sheep scab mites the temperature should be 120° F., and the scabs should be completely broken up by means of a corn cob.

3. Arsenious acid	1	lb.
Zinc sulphate	10	"
Water	25	gal.

Dissolve.

4. Arsenious acid (powder)	6	oz.
Potassium carbonate	6	"
Soft soap	6	"
Sulphur	4	"
Hillsboro root (bruised)	2	"
Water	14	gal.

Boil the ingredients in a portion of the water for half an hour, or until the arsenious acid is dissolved; then add the remainder of the water and strain through a coarse sieve.—Merck's Market Report.

CARBOLIC ACID DIP.

Soap	1 pound.
Crude carbolic acid	1 pint.
Water	50 gallons.

Dissolve soap in one gallon or more of boiling water; add acid; stir thoroughly, and add to remainder of the water. Keep the mixture well thinned and do not allow it to get into the mouth, nostrils or eyes of the sheep. Hold each sheep in the bath not less than half a minute.

LOW'S SHEEP DIP.

Tobacco	16 pounds.
Oil of tar	3 pints.
Soda ash	20 pounds.
Soft soap	4 "
Water	50 gallons.

Steep the tobacco in three successive portions of water, expressing each time; then add other ingredients to the liquid.

To Disguise the Taste of Castor Oil.—Hostelly strongly recommends the following formula:

Arom. fl. ext. yerba santa	½ fl. oz.
Fl. ext. licorice	1½ fl. oz.
Oil cloves	18 min.
Oil wintergreen	½ fl. dr.
Oil cinnamon	½ fl. dr.
Sirup	12 fl. oz.
Magnesium carbonate	2 dr.
Alcohol	1 fl. oz.
Simple elixir, to make	1 pint.

—Druggists' Circular.

To Clean Dirty Belts.—A correspondent of the Centralblatt fur die Textil-Industrie who complains that several belts are dirty from drop oil and dust and desires to know how to clean them is told to first wash the belts with warm water and soap, using a sharp, stiff brush, and while still moist, to rub them with a solution of sal ammoniac, which saponifies the oil in them. Immediately thereafter the belts must be rinsed well with lukewarm water and then dried with sufficient tension. While they are still moist the belts are to be rubbed well on the inside, and less on the outside with the following unguent: 1 kilog. (2 lb. ¾ oz.) India rubber heated to 122° F. and mixed with 1 kilog. rectified turpentine oil. After the solution is complete, 780 grammes (27 oz.) bright resin are added, and when it is dissolved, 750 grammes (26½ oz.) yellow wax are added. This mixture, by diligent stirring, is mixed with 3 kilog. (6 lb. 10 oz.) fish oil and 1¼ kilog. (2 lb. 12 oz.) tallow previously dissolved in the former. In the further treatment of the belt, rub the inside only and the outside only the first time as stated. This unguent also replaces the tannin extracted from the leather, prevents the dragging of the belt and imparts elasticity to it.—Industrial Record.

Fertilizers.—

FERTILIZER FOR GARDENS.

Ammonium sulphate	10 parts.
Sodium nitrate	15 "
Ammonium phosphate	30 "
Potassium nitrate	45 "

FERTILIZER FOR LAWNS.

Potassium nitrate	30 parts.
Sodium nitrate	30 "
Calcium sulphate	30 "
Calcium superphosphate	30 "

FERTILIZER FOR FRUIT TREES.

Potassium chloride	100 parts.
Potassium nitrate	500 "
Potassium phosphate	570 "

This total amount of 1,170 grammes to be used for one tree.—Rev. Chem. Ind.

CHEMICAL GUANO, GRANDEAU.

Calcium nitrate	100 parts.
Potassium nitrate	25 "
Potassium phosphate	25 "
Magnesium sulphate	25 "

Dissolve from 4 to 10 grammes of this powder in 1 liter of water, and water each pot plant with this once or twice a month. The plants must be in full vegetation.—Rev. Horticult.

Chloride of Bromine as a Solvent for Gold.—One of the most notable processes of its kind, says the Boston Journal of Commerce, is that recently brought forward by a New Zealand inventor, Dr. Gaze, for the use of chloride of bromine as a solvent for gold, the employment of caustic soda to recover the chlorine and bromine for use, and the recovery of the gold from the solution by electrolysis instead of by chemical precipitants. The most important feature is said to be the method adopted for making the solvent used in gold extracting by means of a containing vessel of about three feet diameter and two feet deep. In this vessel are placed a number of porous cells filled with plain water, each porous cell having a number of carbon rods placed in it, and the containing vessel itself filled with a strong solution of chloride and bromide of sodium, and more carbon rods are immersed in the solution; the whole is fitted with a lid, one set of carbons being connected with one pole of a powerful dynamo machine and the other set with the other pole. On passing a strong current of electricity through the electrodes, the salts are separated, the chlorine and bromine uniting, and the chloride of bromine thus formed is forced into a vessel overhead.

Gold for Decorating Porcelain.—Dissolve in a tared capsule any convenient quantity of pure gold in nitrohydrochloric acid and add to the solution sufficient uranium oxide to impart a rich brown color. Evaporate the liquid to dryness on a sand bath, cool the capsule, and weigh. Then to the residue so ascertained and counted as one part, add:

Sulphur	1 part.
Dammar resin	2 "
Turpentine oil	6 "

With due precautions against the mixture igniting, heat it over a quick fire, with constant agitation, until it becomes homogeneous and acquires a fine reddish brown color. Add while still hot sufficient rosemary oil to give it the consistency of a thick sirup. Finally, for every 100 parts of the gold originally used, add 35 parts of bismuth flux (bismuth trioxide, or bismuthous oxide, obtained by gently igniting basic bismuth nitrate), and let cool.—Bulletin of Pharmacy.

Sea Foam without Ammonia for Barber's Use.—To get a profuse lather in using a shampoo, soap should be present in the liquid or powder, or preferably soap bark. Grease will not be as readily removed as by alkali alone, but that will make no practical difference in most cases.

Potassium carbonate	4 drachms.
White soap	2 ounces.
Tinct. quillaja	2 "
Oil lavender	20 minims.
Alcohol	8 ounces.
Water	8 "

Tanning Sheepskins.—Wash the hide in warm water and remove all the fleshy matter from the inner surface and loose dirt from the woolly side. Now wash in strong, rather warm soapsuds. The old fashioned soft soap made from wood ashes is best. Either rub by hand or gently on a washboard. As soon as thoroughly cleansed and rinsed, press as much of the water out as possible. Add the following mixture to the flesh side; Common salt and ground alum, one-fourth ounce each, and one-half ounce of borax, dissolved in one quart of hot water. When sufficiently cool to work with the hand, add enough rye meal to make a thick paste. Spread the mixture on the flesh side; fold and let remain in a shady, airy place for two weeks; remove the paste and wash. (They may now be dyed with any color used on woolen cloths, if so desired, being careful not to have the dye hot enough to cook the skin.) When nearly dry, scrape the flesh side thoroughly with a dull knife, rub with the hands until the skin is soft and pliable. Comb the wool when dry. A speedier and perhaps as reliable a method is: For one sheepskin, one pound of salt, half pound of alum, two tablespoonfuls of saltpeter. Spread the hide out smoothly as soon as taken from the sheep. Rub the mixture well in, on the flesh side, turn the head to the tail, leaving the woolly side out, roll smoothly and closely, tie with a string and let remain five days. Spread and tack it, woolly side in, against the side of an outhouse. Scrape all the flesh and grease off with a dull knife, wash with warm water and soap, using as much suds as required to remove all fatty and oily matter. While drying, rub sufficiently to keep it soft. —Country Gentleman.

Kerosene Emulsion for Insects on Animals.—

Fresh skimmed milk	1 gallon.
Kerosene	2 "

Churn together until emulsified. Use one gallon of this emulsion to ten of water and apply.

Egg Phosphate.—

Lemon or orange sirup	1–1½	ounces.
Compound phosphate solution	1–2	fluid drachms.
Shaven ice	2	ounces.
Egg	1	

Into the tumbler put the articles in the above order; add ice water two ounces; shake vigorously or pour it from one tumbler to another several times; pour through a strainer and fill up the glass with carbonated water.

Paste for Attaching Paper to Glass.—

Flour	2 tablespoonfuls.
Water	4 ounces.
Potassium bichromate	5 grains.

The flour must be rubbed to a smooth paste with the water, then placed in a saucepan over the fire, and kept stirred until it boils. Add the bichromate slowly, stirring all the time; then stand to cool. The paste must be kept in the dark, and used as soon as possible. Soak the paper in it, and attach to the glass, then place in direct sunlight for a day. This sets up a chemical change in the bichromate, and renders the paste insoluble.

A CAMERA SWINGBACK INDICATOR AND HOW TO MAKE IT.

By Rev. F. C. LAMBERT, M.A.

SOME years ago I tried various forms of plumb indicators, circular, oblong and other shaped spirit levels, but very soon came back to a simple home made article which the experience of time has firmly established in my affections. Like many useful things, it is characterized by extreme simplicity, and can be made and fitted to any ordinary stand camera by any who can use his hands with a modicum of deftness. We need, for a whole plate camera, for example, one moderately stout, straight, steel knitting needle (generally sold in sets of four for one penny or so, at any draper's or fancy shop), a couple of moderately stout pins, a pair of round nosed pliers, and a pair of square-end cutting pliers and a candle or gas flame. The round nosed pliers are not a necessity, but a convenience.

Proceed as follows: Select a perfectly straight knitting needle. (Its straightness can be tested by laying on a sheet of glass, old negative, etc., and rolling back and forward by laying the finger on it about the middle of the needle.)

Slowly heat one end of the needle in the candle, spirit lamp, or gas flame or fire, until red hot, then seizing this end with the pliers, give it a loop end, such as is shown in Fig. 1. Heat it again at the neck, and bend the neck slightly back to come into the form shown in Fig. 2. Now take one of your fairly long but not very stout pins. Cut off the head quite close, and in a slanting direction, so as to give its thick end somewhat of a point, a, then bend it (cold) into the form shown in Fig. 3; the loop, b, is purposely exaggerated in its distance from the pointed arm, c, but a very slight distance between b and c is only really needful.

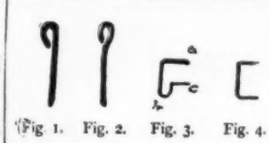


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

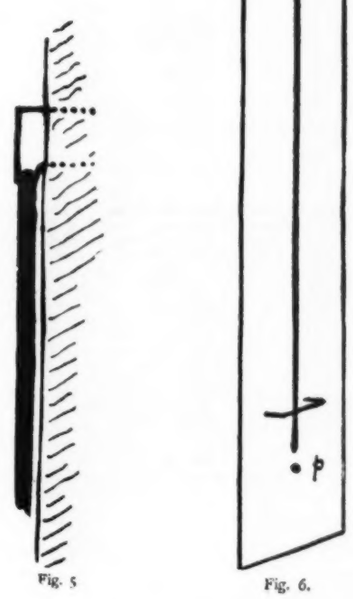


Fig. 5 Fig. 6.

The second pin is decapitated, pointed and then bent into the form of a square staple, as shown in Fig. 4.

Now, to fix the apparatus. The camera is opened out, and the side opposite to that where the slides go in and out selected.

As the contrivance is intended to show when the swingback is vertical, it must be fixed to the part which swings, but not to the reversing part. With the aid of a stout needle held by the pliers, small holes are made to receive the points or ends of the staple, 3.

The knitting needle loop is passed into the loop, b, and the staple then gently driven home until the curved part only projects, as shown in Fig. 5. It will now be seen that the use and object of the curved part of the pin is just, and only just, to prevent the hanging long needle touching the wood. If the staple were square, as in 4, this would be the case, and it would not swing freely. The square staple, 4, is used about a quarter of an inch above the straight end of the needle to confine the swing to reasonable limits. The final arrangement of parts is shown in Fig. 6, which I hope is sufficiently self-explanatory. The dot below the end of the needle, marked p, is the point which shows where the end of the needle ought to be when the swingback is quite vertical. A small white pin is selected, and the head part cut off to within about a quarter of an inch, using the cutting pliers aslant, so as to leave somewhat of a point. This is then gently driven into the wood, so as to leave the head quite flush with the wood surface when the vertical point is ascertained.

In this way this needle serves a twofold purpose, and it shows when the swingback is vertical, and also shows when the top of the camera is horizontal. For if we glance at it sideways, having the view of things as shown in Fig. 5, we can see that the needle is hanging clear, i. e., not touching the wood on the one side, and not the bottom staple on the other.

One or two words of caution are perhaps needed:

(1) If the point of the needle projects below the

bottom staple more than a quarter of an inch, the focusing cloth is liable to get caught in it, and the camera may be upset.

(2) The needle must be quite straight or it will not swing freely.

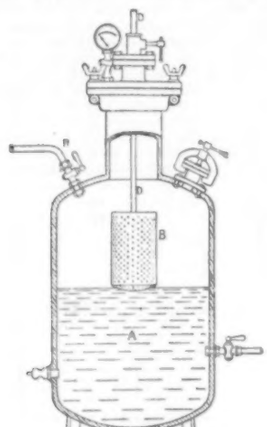
(3) The longer it is, the more sensitive and delicate its indications. It need not, however, exceed about seven or eight inches in any case, but for a quarter-plate camera it should be as long as is convenient.

(4) It should be rubbed now and again with vaseline to prevent rust. If the least bit of rust gets in the loop, b, it is apt to stick. In all cases, therefore, touch it lightly with the finger to see that it is in healthy working order.

(5) The very stout needles are not so good as the moderate sizes, as the former are generally much thicker with the needle than toward the ends, and therefore rub against the wood and do not swing so freely.

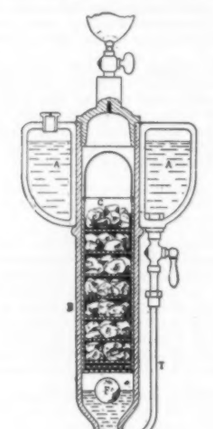
ACETYLENE FOR DOMESTIC LIGHTING.

THERE is a phenomenon about to occur, the importance of which it is well to emphasize, since it marks an abrupt halt, almost a reaction, in the social evolution of recent years. In fact, centralization is now everywhere triumphing. Large cities are absorbing the inhabitants of the rural districts and forming a void in villages; large stores are prospering at the expense of humbler establishments; and transportation is in the hands of large companies. And yet the reign of the large gas and electric light companies is about over, for the possibility of producing at will all the light that one has need of at home, and with a compact and cheap apparatus, will shortly be realized. The agent of this economic revolution is a gas, a carburet of hydrogen—acetylene.



SECTION OF AN ACETYLENE GENERATOR.

A, water reservoir; D, rod carrying the carburet of calcium basket, B; R, tube through which the acetylene makes its exit.



SECTION OF A PORTABLE LAMP.

A, water reservoir; T, tube for entrance of the water; B, large tube containing the carburet cylinder, C; F, rubber ball valve.

It was the great chemist Berthelot who first studied acetylene. This was in 1862. He made known the remarkable properties of this gas, and especially its intense illuminating power, and succeeded in effecting the synthesis of it by combining the two elements carbon and hydrogen, under the action of the electric arc. This memorable experiment was the forerunner of all the discoveries that have been made by the chemists of the entire world for the last thirty years. But acetylene remained a laboratory gas for a long time, since it was possible to obtain but small quantities of it, and that only by costly processes. It belonged to Mr. Moissan, another French scientist, to discover a method of manufacturing it industrially.

It had been found that upon putting carburet of calcium in contact with water, there immediately occurred a tumultuous disengagement of various gases, among which acetylene predominated. As the carburet of calcium was impure, the acetylene was likewise charged with impurities. The method of obtaining pure carburet of calcium was pointed out by Mr. Moissan. In the month of March, 1894, he submitted to the Academy of Sciences some specimens of crystallized carburet of calcium obtained in the simplest manner in the same electric furnace by means of which he had manufactured diamonds. It suffices to place in this furnace, in the presence of two carbon electrodes, between which circulates an electric current of great intensity capable of developing a temperature of 3,000°, a mixture of carbon and lime in order to cause the calcium to immediately combine with the carbon in giving rise to pure carburet of calcium, while at the same time the oxygen of the lime unites with a part of the carbon and forms carbonic oxide. The carburet of calcium liquefies under the action of the intense heat developed in the electric furnace, and, in cooling, solidifies into a compact mass of a slightly reddish brown gray, with a sharp crystalline fracture.

If this pure carburet of calcium be put in contact with water, the latter will be immediately decomposed, the hydrogen of the water will form pure acetylene with the carbon of the carburet, and the oxygen of the water, in going over to the carburet of calcium, will recompose the primitive lime, which will become hydrated in contact with the excess of water.

It is easy to understand the illuminating power of acetylene. The brilliancy of a flame depends upon the quantity of solid matter that it contains. The reason that a candle and illuminating gas burn with brilliancy is because, in consequence of incomplete combustion, carbon set at liberty and rendered incandescent exists in their flame. The pale flame of hydrogen will become very brilliant if some such solid body as quicklime, magnesium or platinum be introduced into it. The Auer burner owes its remarkable luster to the introduction of a cylinder covered with zircon, thorine and other infusible oxides, raised to incandescence, into the but slightly illuminating but very hot flame of the burner. Now, of all the carburets of hydrogen, acetylene is the richest in carbon. Its chemical formula is C^2H^2, while that of methane, which is predominant in illuminating gas obtained by the distillation of coal, is CH^4. One volume of acetylene therefore contains twice more carbon and twice less hydrogen than an equal volume of methane, and, it may be said, than an equal volume of illuminating gas. Consequently as the flame of acetylene contains a large number of particles of incandescent carbon, it has an intense illuminating power.

Mr. Bullier, preparator to Mr. Moissan, appreciating the industrial value of the discovery made by his chief, has installed in Buffon Street a small laboratory where he is producing acetylene by means of carburet of calcium manufactured in an establishment of the Est and collected in gasometers.

If we endeavor to burn acetylene at the ordinary pressure, the flame produced will be fuliginous, owing to the fact that, since the gas is very rich in carbon, a portion of the latter escapes during combustion. In order to increase the surface of contact with the oxygen of the surrounding air, Mr. Bullier dilutes the acetylene with an inert gas (nitrogen, for example). The gas that reaches the burners is a mixture of 85 per cent. acetylene and 15 per cent. nitrogen. Such dilution presents a second advantage, that of preventing the re-entrance of air into the gasometer or conduits, and consequently prevents the production of the detonating mixtures that the air forms with acetylene, as it does, moreover, with ordinary illuminating gas. The net cost of the nitrogen is insignificant.

The apparatus for producing acetylene is installed in a corner of the laboratory. We give a general view and a section of the generator. The apparatus consists of a cylindrical reservoir two-thirds full of water and capable of withstanding a pressure of from 10 to 12 atmospheres. In the upper part there slides by friction a rod that supports a perforated basket capable of holding 11 pounds of carburet of calcium. Upon lowering the rod, the carburet comes into contact with the water, and acetylene is disengaged and develops sufficient pressure to force it directly into the gasometer. The pressure is indicated by a manometer.

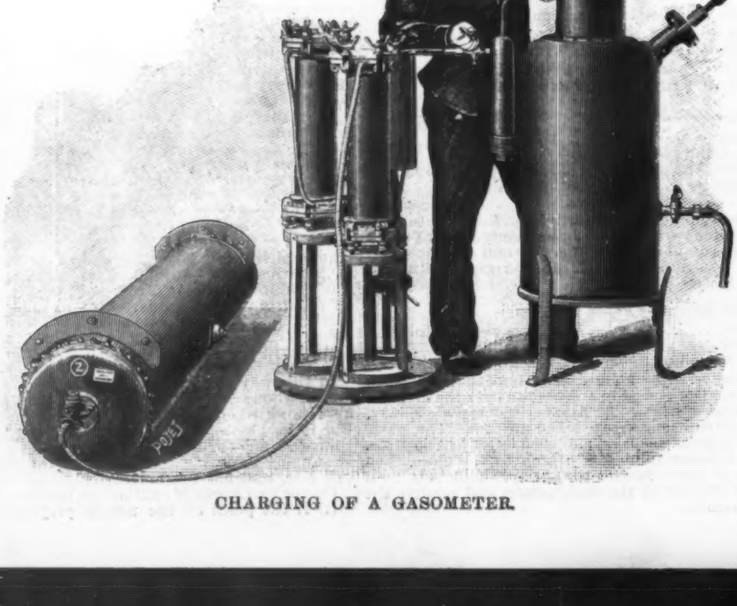
If it becomes too strong, the rod that carries the basket is raised, and the disengagement of the gas ceases as soon as the carburet is no longer in contact with the water. The apparatus is completed by a worm in which the acetylene is cooled, and by two driers containing mineral wool for absorbing the water carried along by the gas. When the carburet is exhausted, the lime that has deposited in the basket is removed, as is also that which has fallen to the bottom of the reservoir; and the supply is renewed.

Every one will be able to have an apparatus analogous to this in his own house. As one pound of carburet of calcium gives about four and one-half cubic feet of acetylene, each charge of the basket will produce 49 cubic feet of illuminating gas. Now, accurate photometric measurements establish the fact that 427 cubic inches of acetylene suffice to give one carcel hour, that is to say, to produce the light of a type carcel lamp or of a butterfly gas burner, for one hour. It requires 4 cubic feet of coal gas to obtain one carcel hour. Acetylene is therefore fifteen times more luminous than ordinary gas. A single charge of the acetylene generating apparatus will furnish more than 214 carcels-hour, or in other words, a light of 21 carcels for 10 hours.

Acetylene appears to afford a practical solution of domestic lighting. Small portable acetylene lamps will soon be offered to the public. We have had one of these placed at our disposal and have been able to assure ourselves that it operates very well. This lamp, of which a section is shown in one of our figures, consists essentially of two communicating tubes, the narrower one of which is connected with a reservoir containing water, and the wider one incloses a perforated cylinder containing the carburet of calcium. If the cock of the small tube be opened, the water of the reservoir will descend, and by virtue of the principle of communicating vessels will enter the large tube through the bottom in lifting a small rubber ball. As soon as the water comes into contact with the carburet, acetylene is disengaged, the pressure forces back the water, and the little rubber ball forms a valve. When, the burner being opened and lighted, the gas is burning, the pressure diminishes, the water ascends in the large tube, and a new disengagement of gas takes place in consequence of the contact of the water with the carburet. The lime deposits in the cylinder or falls into the foot of the lamp. In this small sized lamp there may be placed 4 ounces of carburet, sufficient to produce about one cubic foot of acetylene, and give a light of one carcel for four hours. The spent carburet is easily replaced.

The railway companies (the Paris-Lyons-Mediterranean line, the first) have acetylene under trial for the lighting of their cars. During the last presidential trip, two cars of the special train were thus lighted. The acetylene was stored in reservoirs placed under the frame of the cars. These reservoirs contained 125 cubic feet under a pressure of 15 pounds. The burners employed were of feeble discharge and gave an illuminating power of one carcel and a half with a consumption of but 670 cubic inches an hour. The light obtained was truly dazzling, and of absolute whiteness and steadiness. How different from that wan and flickering light that our travelers, even of the first classs, are to-day condemned to suffer!

Acetylene is therefore the light of the future, and of a very near future. The net cost of the gas depends upon that of the carburet of calcium. Such cost is still high—say $90 a ton. This, at the rate of about 4½ cubic feet of gas to the pound of carburet, puts the price of a cubic foot of acetylene at about a cent. As a cubic foot of coal gas, although costing five times less, gives fifteen times less light, it follows that it is now possible for the same price to obtain three times better light with acetylene than with coal gas. We must an-



CHARGING OF A GASOMETER.

ticipate a rapid dimunition in the price of carburet of calcium when the manufacture of this substance comes to be effected industrially and in large quantities.—L'Illustration.

TESTS OF THE BALTIMORE ELECTRIC LOCOMOTIVE.

SOME interesting tests have been made with the electric locomotive used for hauling trains through the belt line tunnel of Baltimore. By its means a reduction of 16 minutes in the running time of the "Blue Line" trains between New York and Washington is now made possible, and it is probable that this saving will be increased later on. Moreover, all delays in winter, due to ice in the river, are done away with.

Probably the most striking test of the power of the locomotive was when two trains were coupled together and hauled through the tunnel. For some reason, says the Electric Railway Gazette, to which we are indebted for these particulars, the freight trains had become "bunched" on the Washington division, and when they did get through they came so fast that it was decided to have the electric locomotive haul them two at a time. The first composite train, therefore, consisted of 44 cars, loaded with coal and lumber, two regular steam freight engines and a steam "pusher" engine. The whole weight was approximately 1,960 tons, and was equivalent to about 52 loaded cars. The steam locomotives did no work to assist the electric locomotive. The start was made easily and gradually, but when the train was in the tunnel and entirely on the grade the steady, heavy pull was too severe on a defective coupling near the head of the train, and it parted. After coupling together again, the electric locomotive started the heavy train, with all drawbars stretched—no slack in the train—and accelerated it to a speed of 12 miles an hour without slipping a wheel, and in every way with the greatest ease. It reminded one of the start of an ocean steamship, so noiseless was it and free from any manifestations other than those of mighty power. The current recorded on the ammeter was about 2,200 amperes during the acceleration period, and after the train was up to speed it settled down to about 1,800 amperes. The voltage on the line was 625. By reading the amperes the drawbar pull was readily computed and found to be about 63,000 pounds. All four motors were in series, and the maximum pull for that current was therefore obtained.

To determine the drawbar pull exerted for each ampere of current, the Pennsylvania Railway Company's dynamometer car was secured and coupled in between the electric locomotive and a train of known weight. The weight of each car in pounds had been accurately determined beforehand. The regular two mile haul up grade was then made. When the train was in the tunnel on the grade the pull was uniform, as was shown in the diagrams taken on the dynamometer car.

The first test showed (a) how the start was made on the down grade leading to the tunnel; (b) how after the train was fully started the drawbar pull dropped off; then (c) how it gradually increased as the train came on to the 0·8 per cent. grade in the tunnel; and (d) after the train was wholly on the grade, how even the pull was, until near the stop, when the grade increases 1·2 per cent. It was found that 144 amperes were required to drive the locomotive. The diagram shows the current and drawbar pull at any moment while accelerating the train.

For the operation of the Baltimore & Ohio tunnel power house for the month of October, 1895, the itemized expenses were as follows:

Labor	$1,345 70
Coal ($1.35 per ton)	400 96
Oil and waste	151 26
Water	50 66
Maintenance	25 42
Total	$1,974 00

The expense on electrical locomotives was:

Motor engineers	$200 00
Oil and waste	12 16
Total	$212 16
Total expense	$2,186 16

There were hauled through the tunnel 353 trains.

Average weight of train	1,095 tons
" time of trip	20 minutes
" current	986 amperes
Distance of trip	4 miles
Total engine travel	1,412 miles
Total engine travel "idle"	3,756 miles
Actual time consumed for above service	118 hours
Idle time for month	626 hours

It is customary to consider an engine with steam up as equivalent to six engine miles for each hour it is idle, so that, for comparison, the actual mileage made by the engines must be increased: $6 \times 626 = 3{,}756$ miles.

The large charge of labor at power house will be the same for one, two and three locomotives in service. The items, coal, water, and maintenance, and the expense on locomotives, increase with the number of locomotives in service. If this increase is assumed to be proportional, the total expense and cost per engine mile are as follows

	Total cost.	Engine miles.	Cost per engine mile.
For one locomotive	$2,186.16	5,168	$0.423
" two locomotives	2,875.36	10,336	0.278
" three "	3,564.56	15,504	0.23

The steam railway records referred to above are for October, 1895, and may be briefly abstracted as follows:

STEAM LOCOMOTIVE PERFORMANCE.

	East Div.	West Div.	Central Div.	N. & W. Div.	Entire Line.
Locomotives in service	74	57	33	28	192
Average engine mileage in service	2,834	2,966	2,266	2,305	2,708
Average cost per engine mile:					
Passenger engines	0.1996	0.1666	0.1629	0.1552	0.1765
Freight "	0.2472	0.2656	0.3428	0.2903	0.3015
Switching "	0.1489	0.1659	0.1828	0.1435	0.1577
Work "	0.2391	0.2258	0.3017	0.2160	0.2354
Total "	0.2084	0.2103	0.2721	0.1797	0.2095

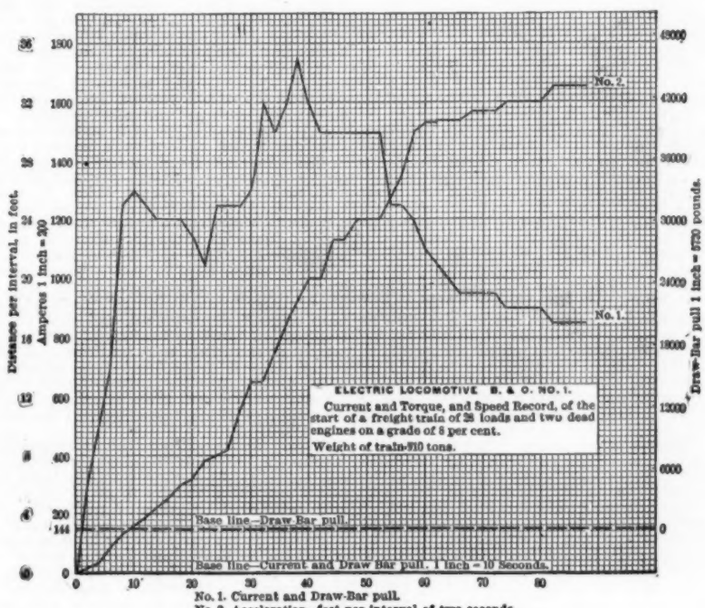
From the figures above it is seen that the actual operating expenses of the electric locomotives for that particular month are about the same as for the freight locomotives on the steam railway, i. e., 23 cents per engine mile. The service of the electric locomotives at that time was only about one-third that which it is expected they will have to do when the passenger service is taken up and the line extended the full distance.

As originally intended, a method of using to advantage the power of the station while the electrical locomotives are idle is soon to be incorporated in the plant. Under the new conditions the cost per engine mile for the electric locomotives will be far under that of steam.

A comparison of the efficiency of steam and electric locomotives shows slightly in favor of the electric. Observations made on French railways and on the Pennsylvania Railway show that about 45 per cent. to 55 per cent. only of the indicated horse power of steam locomotives is applied to hauling trains. The efficiency of the Baltimore & Ohio plant is in the vicinity of 60 per cent. to 65 per cent. under normal conditions.

The conductor in the tunnel has now been in position for nine months. During all of this time coke burning locomotives have been used for passenger service, with the consequent presence of a good deal of gas and vapor. For the first six months about half of the conductor was constantly wet from the drip due to leaks in the masonry. This occasioned a muddy, slimy deposit over the insulators and a considerable portion of the conductor. The porcelain insulators are almost entirely obscured in some places by this deposit and that of small particles of carbon given off by the locomotives.

Current was first turned on the line about three months after the tunnel structure was erected. The leak at first was about 21 amperes, but in a day or two this dropped to about four amperes—the present leakage. The inside of the conductor was coated with a combined deposit of rust and muddy sediment. Heavy currents were taken from it by the contact shoe only with difficulty, and the presence of much arcing, heating and showers of sparks. It was found impracticable to run on this surface. By applications of kerosene and frequent scraping with special shoes, a direct contact of the trolley shoe with the conductor was made possible. Although a single contact shoe then worked with little or no sparking, two shoes in tandem were adopted. Their operation through the conductor is smoother, and the contact over muddy portions of it is more nearly positive. At intervals of about three weeks the conductor is treated with kerosene, and brushing shoes are run through it, about one or two trips with these brushing shoes being all that is necessary. This serves to prevent further accumulation of rust, and to remove the sediment from the contact surfaces. An inspection shows a smooth surface over which the shoes run. Contact with the metal is seen to be in high spots and thin lines, which are slowly increasing in extent. No considerable sparking now occurs, except at the wet places, where it is occasioned by the presence of water and sediment. With the exception of three places, about 200 feet long each, the conductor is at present entirely dry.


Distance per interval, in feet.
Amperes 1 inch = 300
Draw-Bar pull 1 inch = 6720 pounds.
No. 2.
No. 1.
ELECTRIC LOCOMOTIVE B. & O. NO. 1.
Current and Torque, and Speed Record, of the start of a Freight train of 28 loads and two dead engines on a grade of 8 per cent.
Weight of train-910 tons.
Base line—Draw Bar pull.
Base line—Current and Draw Bar pull. 1 inch = 10 Seconds.

No. 1. Current and Draw-Bar pull.
No. 2. Acceleration—feet per interval of two seconds.

CURVES SHOWING RELATION BETWEEN CURRENT CONSUMPTION AND WORK.

PRESENT AND PROSPECTIVE DEVELOPMENT OF ELECTRIC TRAMWAYS.*

IT seems hardly necessary to review the past development of electric tramways; it has been made apparent on every side of us, commencing, it may be said, with the introduction of electric motors on a large scale on the roads of Richmond, Va., about seven years ago, by the old Sprague Company. This road developed the system in its main features as it stands to-day, two motors being mounted, independent of the car body, on the truck, and driving to the axle by gear. With the improvements and modifications which seven years have brought into the field, this system stands in the main what Mr. Sprague made it at that time.

The first motors installed on this road were seven and a half horse power each. Later on these were changed to ten horse power, and a year or two later fifteen horse power motors became the standard. Then twenty, and now two twenty-five horse power motors are the standard street railway equipment which is generally made.

Street railway managers were soon attracted by the results there shown, and the next large system to follow Richmond was Mr. Whitney's then new consolidated system in Boston, the West End Railroad. There the Thomson-Houston Company practically had the field for enterprise and experiment, and carried on still further the development which had been started at Richmond, working out still larger problems than had there been undertaken. The result is to-day that, outside of a few cable roads, there is not a street railway system of any size in the country where electric traction has not been or is not being now introduced on an extended scale, requiring enormous additional outlay of capital in this installation.

The advantage of electric traction was that it was equally available to the little cross country horse line or the largest system in our large cities, and under the heaviest conditions of traffic and service. One of the first results of its introduction was the satisfying of the demand for more rapid transit, and the large increase in gross and net earnings, and the reduction of operating expenses, especially on the question of power. One of the early fields to be developed was the interurban service between cities, for connecting small towns with large cities. One of the first and most marked examples of this kind was the interurban service between Minneapolis and St. Paul. After its establishment it compelled six different steam roads to practically abandon the service they had been maintaining between these cities.

The amount of capital and the confidence with which capitalists and investors have taken hold of the electric tramway has been something marvelous, when we consider the short time it has been in service, and though you might find a few failures owing to poor management, over-capitalization, or some other sufficient cause, in general we find an uninterrupted line of successful extensions and enterprises in this line. I will try to make a brief general review of the different parts of the electric tramway system, and show the development which has been made in each.

Roadbed.—There is probably no part of a street railway system which was more antiquated in its general construction than the majority of the roadbeds were found in this country when cable and electric traction were first introduced, and it took some severe lessons in many cases to bring about appreciation of the necessity of good roadbed construction. The old horse road construction was in somewhat the condition of the old steam road construction fifty years ago, being a stringer construction, with ties four to five feet on centers in the majority of cases, and a flat rail, either center or side bearing, and weighing from thirty to sixty pounds to the yard, spiked to the top of the stringers. The result naturally reached with the

* Digest of a paper by C. J. Field at the meeting of the American Society of Mechanical Engineers.

introduction of electric traction on such a track, with its heavy service and severe wear and tear owing to self-propulsion, was a failure of the roadbed entirely. On paved streets the ties had to be placed sufficiently low to enable the use of paving blocks over them. Therefore, with the commencement of the introduction of girder and T rails, which when first introduced were three to four inches, and in some cases five inches, in depth, it required the placing of these rails on a cast or wrought iron chair or stringer in order to get the depth over ties for paving. This method proved very little better than the old flat rail, under the added requirements of the service, and especially at the joints; and contracting engineers and officials of street railway companies very rapidly reached the appreciation of the necessity of using the heaviest possible rails obtainable, and the rail mills were pressed to undertake the rolling of heavier and deeper girder and T rail, and after overcoming all difficulties they have reached at present a state of development which gives us, we believe, a roadbed construction equal to that of any steam road in the country; and the standard to-day for electric tramway roadbed is seventy to eighty pound T rail, or seventy to ninety-eight pound girder rail, the depth of these rails running from seven to nine inches.

Ninety pound rail, being nine to ten inches in depth, enables them to be spiked direct to the ties and give the necessary depth for paving. This heavy rail, with eight to twelve bolt joint plates, supplies every requirement. The girder rail is being generally used in paved streets and T rail on suburban roads, and, for the last year or two, to a considerable extent on macadamized roads, and even in a few cases on paved streets. By the introduction of special details of construction, and especially on macadamized and asphalted streets, the T rail seems to offer as good a roadbed, both for the railroad and the public, as the side-bearing girder rail. Ties used should be standard railroad ties.

The special work on track work, such as crossovers, turnouts, curves, etc., has also met with large improvement. We have as a standard for this special work the steel rails bent to the form required, and surrounded by a mass of cast metal to hold them together, and one company is turning out this special work with the parts welded together; also in cast steel. One company is introducing track work in which, instead of joining up the rails with channel and joint plates bolted together, the rail is being welded electrically into a continuous rail.

Track Bonding and Electrolysis.—We are hearing a great deal to-day about electrolysis and electrolytic action of the current on the return side of the tramway circuit. In the early introduction of electric tramways, and with the light section of rails, the usual method was to bond up the rails and connect them with the return copper or iron wire of varying sizes which was laid between the rails. At first the size was Nos. 4 and 6 wire, and later on 0 and 00 was used. With the introduction of a seventy and ninety pound section of rail we have met the question of sufficient capacity in the conductivity of the rail. The present requirements are to bond the rail in such a manner as to insure a continuous connection of all the tracks, and thus provide means for the return connection to the power station, and we believe it may be said that the best standard of construction to-day is to double bond all the joints of the rail with the shortest possible bond which is practicable, and cross bond each rail every few lengths and also cross bond to the other track. This insures a uniformity of potential in the rails. Then, by connecting this track by overhead feeders run in the same manner as the feeders to the trolley, connected every half mile or so to the track, we believe we have a practical solution of the difficulties which have been encountered in the proper return of the current, and a prevention of the trouble which has been encountered where this return was not sufficiently provided for, and the current, taking to the water and gas mains, has caused the trouble and damage resulting from the same.

Line Construction.—When we run across some of the old cases of line construction, as at Richmond and other places, and then compare them with the present form of construction which is now being introduced, it gives us a better illustration than words can describe of the improvement which has been made in overcoming the objections which existed in the earlier work. Then we had for insulation old pieces of glass and porcelain and little blocks of wood, the whole making a poor mechanical and electrical job, and giving considerable trouble.

The standard of trolley wire then was No. 4. Now the standard is a No. 0 or 00 wire. Then the poles used were plain little telegraph poles, about six inches at the top and eight inches at the butt, which quickly gave way under the strain of service. Now we have a well built line, substantial in every respect. The poles used are either a heavy octagonal sawed pole or various types of iron poles. Local city authorities, though, have compelled the use of iron poles in most cases, and various types of pipe and trussed sectional iron poles have been introduced. The difficulty with the iron pole construction is to get good insulation between the trolley wire and the ground.

Feeder Wire.—Feeder wires have been more and more liberally introduced and used, and at present, on the best construction, the system is laid out and figured to maintain a distribution of potential over the entire system with a drop of not exceeding 5 to 8 per cent, under the most severe conditions or heavy stress of weather. Feeder wires in general have been run overhead, but we believe it is an assurance of better service on large roads to run the main feeder trunk lines in underground conduits, and we have done this in several cities with successful results.

Underground Conduits.—Underground conduits, or the placing of the trolley wire with all its feeders under the surface of the street, is the ultimate and desirable result to be obtained in our large city lines of electric traction, and cities are going to demand in the near future this method of service where the local conditions and requirements will warrant it. Underground conduits were attempted four or five years ago, but on account of insufficient experience, lack of engineering ability, or amount of money expended on the work, as well as a desire on the part of the company installing them to make them a failure, they were not in general successful. The first really successful underground conduit to be installed and operated was in Buda-Pesth.

The other type of conduit which may be used is one of the several which are operated on the closed conduit plan. It is a very attractive method in many ways, also saving on the cost of construction of a cable conduit. There are numerous difficulties in regard to the electrical details which will have to be overcome before such a form of duct can be a success. The overhead line construction, though, will continue to be used in the majority of cases for many years to come, we believe, as the most practicable and best method for conveying the current to the motors. The cost of a well built trolley conduit in the form of a cable duct will, in most cases, exceed that of a cable duct on straight track, but less on curves and special work.

Cars.—We believe the best standard of car for heavy city traffic, and one which will give the least wear and tear on the roadbed, and also will enable the use of higher speed on suburban lines, is a car body from twenty to twenty-four feet in length—twenty-one or twenty-two feet being the most desirable standard—and mounted on double trucks, with maximum traction on the driving wheels. Such a car body, with wide platforms—four to four and a half feet—with entrances on one side, with wide double doors, fills best, we believe, the general requirements of such a service. There is a strong objection to the use of nineteen or twenty foot car bodies on a single truck, with a six and a half to seven foot wheel base, as has been done in a number of cases. There can be only one result from such an equipment, and that is a rapid destruction of the car body and also the track. This pounding or destruction of the track on these single trucks has to a considerable extent been due to the weight of the cast iron motors and their rigid mounting on the car axle. This difficulty has been greatly lessened by the introduction of steel motors of about half the weight, and the supporting of them by springs.

Motor Equipments.—The improvement in motors during the past seven years, since their first introduction, has been marvelous. The old seven and a half or ten horse power motor was a thing of pity, poor in its design both mechanically and electrically, and a continual worry and trouble to keep it in operation and service, the fields and armatures burning out every day, and the repair account on them running from three to six cents per car mile operated. Now if we turn to the present type of iron-clad slotted armatures and waterproof motors, with normal horse capacity, in the general type of motors of twenty-five horse power, making equipment per car fifty horse power, and built for any speed which is practicable on the service for which they are to be used, with a depreciation, wear, and tear less than almost any other type of power machinery, we have, it seems, attained a commercial stage and development in this motor which it will be hard to excel. These motors are now equal to almost anything to which they may be put. Their capacity, economy, and power are brought to a high stage of development, and their economical controlling and handling is managed by a controller stand which gives various combinations and arrangements of the motor fields and armature, which gives us complete control over the current under different conditions of service, and gives us an economy in current consumption which is away beyond the expectations of a few years ago.

Power House.—From the mechanical engineer's standpoint, probably the most interesting part of the equipment of the electric tramway is the power house, and therefore we will try to give you a more careful and detailed description of its present development and arrangement. The one central idea of electrical engineers, in the early electric light and power station work, was to have them located in the center of the system, regardless of all other local conditions and requirements. Experience has shown us, in the broad treatment from an electrical and mechanical engineer's standpoint, that we want to take into careful consideration not only the electrical requirements as to the distribution of power, but also the possibilities of economical generation of that power from a steam engineering standpoint; therefore we give careful consideration at present to this matter. The general requirements are that a power station of any size or capacity should be so located as to generate, under the most economical conditions, the power which is to be used in the utilization of electricity, and the location to be such that the obtaining and handling of coal and water shall be at the lowest obtainable net cost. The capacity of the station should take into consideration the present requirements and immediate future expectations as far as can be foreseen, and as far as the resources of the company will permit on a commercial scale, and without depending too much on future prosperity.

The general basis of calculation of the horse power required for a tramway system must take into consideration the local conditions of service, grades, curves, etc., but, in general, fifteen to twenty-five horse power per car equipment in use on the road is the general limit of a well designed station, which will take into consideration the conditions for the continuous service and operation of the plant. A road of one hundred cars would, therefore, require about two thousand horse power, which horse power should be divided into say four units of five hundred horse power each. The number of units in any station should be the fewest number which will give a safe and economical division of the units, and in a station of this kind four or five units, according to the service and conditions, should be the standard. In the past we have had to be guided largely by the capacity and size of generators it was possible to obtain, but this question is now eliminated, and any capacity of generator which the engineer may call for and feel necessary to meet the needs of his case can be contracted for and built with a surety of success. Generators are now being built in this country up to five thousand horse power each. At present the tendency is large generators directly connected to the engine, whether automatic or Corliss, high, slow, or intermediate speed, such connection being made either by direct belting or directly mounting the generator on the engine shaft. The type of engine to be used on this service we have found must be equal in its requirements to that of rolling mill service, capable of standing the heaviest strains in the variation of the load, and also to give desirable closeness in regulation under these heavy changes, in order that our generators may be balanced with one another.

In boilers we have a wide range in style, size, and capacity. The plain old horizontal return tubular, sixteen or seventeen feet long, with three and a half or four inch tubes, is still filling general requirements in a large number of cases in a satisfactory manner, where real estate has not to be purchased at an excessive cost, and where the steam pressure does not exceed one hundred and twenty-five pounds. Such a boiler, made with good material, with a butt strap joint, gives us good service. Where the conditions are such that we require water tube or sectional boilers, we have a large variety to select from, many of them meeting our requirements and giving good service; but a number of them we find are giving a good deal of trouble and bother in their care and maintenance, and also in not giving good dry steam.

Operating Expenses and Cost of Equipment.—The old horse car road in large cities operated at a total cost of from eighteen to twenty-five cents per car mile. One car mile is taken as the standard for operating expenses in our tramway service. The heaviest item in this operating expense was the question of power; that is, the care and maintenance of the horses, their feeding, and the depreciation of the same. The average life of a horse on a well operated tramway road is five to six years, and the number of horses required per car from eight to eleven, according to conditions and requirements. The cost of this power service was from eight to eleven cents per car mile. This is where the electric road has made its heaviest gains in the reduction of operating expenses. This item is reduced in power service to-day to a cost, under general conditions, ranging from one to one and one-half cents per car mile. Is not this a marvelous gain in a few years, and does it not indicate and show the possibilities of the introduction of this power on this service? The relative proportion of operating expenses to earnings in the horse railway service was from seventy to eighty per cent, operating expenses to gross earnings. In electric service we have a considerable increase in our gross earnings over our old horse line, which increase runs from twenty-five to fifty and even one hundred per per cent, in some cases, and the operating expenses being forty to sixty per cent, of the gross earnings. In this operating expense we include all the operating expenses of the road other than the fixed charges.

The cost of building and equipping an electric road is considerable. The standard price four years ago for two fifteen horse power motors and the installation of them was $3,000 to $3,500. The price to-day for two twenty-five horse power motors, which are much superior to the former ones, is under $1,000. This gives us a total cost of a motor car, including car body, truck, motors, etc., of approximately $2,200. A single mile of roadbed construction, with ninety-pound girder rail, exclusive of any new pavement, but including taking up of the old track and replacing of old pavement, about $7,500 per mile of single track. This makes no allowance for special work. Overhead line construction for one mile of double track, with iron poles, feeders, etc., $4,000 to $5,000 per mile; with wooden poles, about $3,000 or $4,000 per mile. Steam and electric plant for direct-connected vertical compound condensing plant—for, steam plant, $50 to $55 per horse power, and the electrical, $20 to $25 per horse power, making a total for steam and electric plant, $70 to $80 per horse power. As a general summary, we have for the total cost of the equipment of the electric tram road—that is, the rebuilding of an old horse road—including power plant complete, buildings, car house, cars, equipment, track and overhead construction, $20,000 to $25,000 per mile of single track, according to the varying conditions and requirements of different cases.

Conclusion.—Without going to extremes, I believe we may safely say that the electric tramways have more than met all the requirements, expectations and agreements of even the most enthusiastic advocate during their early introduction, and when we look around us to-day, and see the universal introduction which they have met with in this country, and are now meeting with in all parts of the world, we can in a measure appreciate what has been done in this matter.

As to the future and the future possibilities of the tramway, not only for city and suburban traffic, but also to enter into competition for a large share of the steam railway service, it will see the introduction of electricity for many purposes and uses in this field. The limit of speed and power obtainable is only limited by the conditions and local requirements of this service. Theoretically, any speed is possible which is desirable to be obtained on any service, and the only limits are the resistance of the wind or air. As to the exact line which this development is going to take, it is hard to determine; but we believe for a number of years to come it will be a continuance of the present lines, with improvements in the general detail of construction.

Up to the present time in this service, our development has been with direct or continuous current. There is no question but that, with the large improvements and modifications which are being made in alternating current apparatus, we may expect its introduction on the tramway service, especially for long distance work.

In all this work the mechanical engineer has played and will play an important part, and the combined mechanical and electrical engineer is going to be and has been largely identified with the development of this line of work.

Work has been commenced on the electric road between Baltimore and Washington. The grading of the roadbed on both ends of the line is now being carried out. It is proposed to run cars on this road at a high rate of speed and the tracks are to be built of the heaviest steel rails. The power plant for the road has been contracted for with the Westinghouse Electric Company, there being two power stations, one being located at about ten miles from the Baltimore terminus and the other about ten miles from the Washington terminal. The initial power equipment contracted for is equal to about 6,000 horse power.

A SHORT CIPHER CODE FOR COMMERCIAL USES.

By Dr. EDWARD S. HOLDEN, Director of the Lick Observatory.

NOT long since I was called upon to arrange a cipher code which should be convenient for telegraphing complex astronomical messages, as the elements and ephemerides of comets, etc. Such a one is printed in the publications of the Astronomical Society of the Pacific, No. 49. A part of this code will be of use for commercial purposes also, particularly in transmitting *dates* (month and day) and *numbers*.

One merit of the code is the shortness of its tables, which require only three octavo pages, as below. Care has been taken to choose the combinations of letters which go to make up the cipher words, so that few mistakes are likely to occur in transmitting the messages by telephone. The eye is liable to make one kind of error and the ear a different kind. So far as practicable, both kinds have been avoided in these tables. Large code books, like Slater's excellent Telegraphic Dictionary, will always be required for some uses. The great majority of commercial telegrams can, however, be sent by the following code of three pages. All *dates* are to be sent as words of three letters taken from Table I, and interpreted by Table III; thus *Hil* = one hundredth day of the year = April 10 (in common years or April 9 in leap years). *Numbers* must *always* be sent as compound words of eight letters, composed of a prefix from Table I and of an affix from Table II; thus, *Hilofant* = 10072, *Rokalone* = 28615, *Faninary* = 06356, etc. It will prevent mistakes to write five figures to correspond to every number word, as 00172 for 172 (*Bakofano*), 01724 for 1724 (*Bolative*), 00006 for 6 (*Bafadore*), etc. Words of three letters must be reserved for dates; and the five letter words of Table II should be used only as affixes.

The telegram should be written out in plain English and its dates and numbers should then be turned into cipher, thus: "Send 4,000 cases on June 16, and draw on us for $11,724 July 3" might be written "Send *Dilnicht* cases *Kol*. Draw on us *Hunative Lap*."

In messages with many figures the saving in expense would be considerable over cable lines; and proportionally more over the Western Union lines.

If it is desired to make the messages absolutely secret, this can readily be done.

The sender writes his message in figures, adds some arbitrary number, as 1,171 for instance, to each number, translates the message so transformed into cipher and sends it. The receiver translates the cipher words into numbers and subtracts 1,171 from each number. Other simple devices of the sort are too well known to need description.

I think that the code in question will be convenient in many commercial transactions, on account of its extreme simplicity and shortness.

Its words are pure jargon, of course. But this jargon has been so chosen as to be easily pronounced, and its combinations are so arranged as to make the chance of error a minimum.

EXPLANATION OF TABLES I, II, III.

Precepts: Table I. Read the initial at the top of the column with a combination from the column "Vowels;" as *Hok* = 106, *Noy* = 501.

I. All *numbers* are expressed by words of eight letters. Such words are made up of a *prefix* from Table I with an *affix* from Table II. Thus, 10647 = *Hokience*; 01065 = *Bilitous*. Numbers larger than 50999 must be divided into two parts, A and B, and telegraphed as A + B. Thus, 80711 = 40000 + 40711, which is telegraphed as *Wilnicht* plus *Wolahold*, and so on. When angles are in question, the degrees (only) are given by Table I, and the minutes by Table II; as 357° 29′ = *Tunegate*; 0° 15′ = *Bafalone*.

II. All *dates* are expressed as *local dates* invariably in words of three letters (prefixes) taken from Table I, and interpreted by Table III. *Example:* *Hok* (standing alone) = 106th = April 16 (local date); November 29 = 333d = *Tun*.

TABLE I (PREFIXES).

The table gives numbers (with Table II; *local dates* (if used alone; see Table III).

N. B.—Write three figures to correspond with each prefix. *Example:* *Fil* = 070, not 70.

Vowels.	B	D	F	H	J	K	L	M	P	R	S	T	V	Vowels.	W	Y	Z	N
af	000	030	060	090	120	150	180	210	240	270	300	330	360	*af*	390	420	450	480
ak	001	031	061	091	121	151	181	211	241	271	301	331	361	*ak*	391	421	451	481
al	002	032	062	092	122	152	182	212	242	272	302	332	362	*al*	392	422	452	482
am	003	033	063	093	123	153	183	213	243	273	303	333	363	*am*	393	423	453	483
ap	004	034	064	094	124	154	184	214	244	274	304	334	364	*ap*	394	424	454	484
ar	005	035	065	095	125	155	185	215	245	275	305	335	365	*ar*	395	425	455	485
at	006	036	066	096	126	156	186	216	246	276	306	336	366	*at*	396	426	456	486
as	007	037	067	097	127	157	187	217	247	277	307	337	367	*as*	397	427	457	487
if	008	038	068	098	128	158	188	218	248	278	308	338	368	*if*	398	428	458	488
ik	009	039	069	099	129	159	189	219	249	279	309	339	369	*ik*	399	429	459	489
il	010	040	070	100	130	160	190	220	250	280	310	340	370	*il*	400	430	460	490
in	011	041	071	101	131	161	191	221	251	281	311	341	371	*in*	401	431	461	491
ip	012	042	072	102	132	162	192	222	252	282	312	342	372	*ip*	402	432	462	492
it	013	043	073	103	133	163	193	223	253	283	313	343	373	*it*	403	433	463	493
od	014	044	074	104	134	164	194	224	254	284	314	344	374	*od*	404	434	464	494
of	015	045	075	105	135	165	195	225	255	285	315	345	375	*of*	405	435	465	495
ok	016	046	076	106	136	166	196	226	256	286	316	346	376	*ok*	406	436	466	496
ol	017	047	077	107	137	167	197	227	257	287	317	347	377	*ol*	407	437	467	497
on	018	048	078	108	138	168	198	228	258	288	318	348	378	*on*	408	438	468	498
op	019	049	079	109	139	169	199	229	259	289	319	349	379	*op*	409	439	469	499
or	020	050	080	110	140	170	200	230	260	290	320	350	380	*or*	410	440	470	500
oy	021	051	081	111	141	171	201	231	261	291	321	351	381	*oy*	411	441	471	501
os	022	052	082	112	142	172	202	232	262	292	322	352	382	*os*	412	442	472	502
ud	023	053	083	113	143	173	203	233	263	293	323	353	383	*ud*	413	443	473	503
uf	024	054	084	114	144	174	204	234	264	294	324	354	384	*uf*	414	444	474	504
ug	025	055	085	115	145	175	205	235	265	295	325	355	385	*ug*	415	445	475	505
ul	026	056	086	116	146	176	206	236	266	296	326	356	386	*ul*	416	446	476	506
un	027	057	087	117	147	177	207	237	267	297	327	357	387	*un*	417	447	477	507
up	028	058	088	118	148	178	208	238	268	298	328	358	388	*up*	418	448	478	508
uz	029	059	089	119	149	179	209	239	269	299	329	359	389	*uz*	419	449	479	509

NUMBERS. TABLE II (AFFIXES).

These are always used with prefixes from Table I. N. B.—Write two figures to correspond with each affix. *Example:* Adieu is 04.

00	*-nicht*	**20**	*-arine*	**40**	*-estry*	**60**	*-iplik*	**80**	*-olute*
01	-aband	21	-aship	41	-eting	61	-irekt	81	-omane
02	-abate	22	-aside	42	-event	62	-irize	82	-omist
03	-about	23	-ation	43	-ibale	63	-iside	83	-omous
04	-adieu	24	-ative	44	-ibode	64	-itark	84	-oniks
05	-adize	25	-atrip	45	-ibrew	65	-itous	85	-opsis
06	-adore	26	-avish	46	-ident	66	-iture	86	-orate
07	-aflow	27	-eblow	47	-ience	67	-itude	87	-ordik
08	-afras	28	-educe	48	-ifold	68	-ivate	88	-ormus
09	-agile	29	-egate	49	-ijest	69	-oblat	89	-orous
10	*-aplow*	**30**	*-eplet*	**50**	*-ilade*	**70**	*-ocean*	**90**	*-otlik*
11	-ahold	31	-egraf	51	-ilant	71	-odate	91	-ugale
12	-akute	32	-ejekt	52	-ilege	72	-ofant	92	-ulate
13	-alist	33	-elekt	53	-imate	73	-often	93	-ulent
14	-alive	34	-elope	54	-iment	74	-ogism	94	-ulous
15	-alone	35	-embue	55	-imony	75	-ogive	95	-umate
16	-ament	36	-endow	56	-inary	76	-ogoon	96	-upate
17	-amope	37	-erade	57	-iness	77	-olist	97	-urant
18	-annex	38	-erkin	58	-inize	78	-olize	98	-urile
19	-arose	39	-eroon	59	-inode	79	-olode	99	-usipe

Precepts: To express *numbers*, use Tables I and II; as *Manifold* = 21348. To express *angles*, *Manifold* = 213° 48′.

DATES. TABLE III. DAY OF THE YEAR CORRESPONDING TO EACH MONTH AND DAY (COMMON YEARS).

Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day of Month.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day of Month
1	1	32	60	91	121	152	1	182	213	244	274	305	335	1
2	2	33	61	92	122	153	2	183	214	245	275	306	336	2
3	3	34	62	93	123	154	3	184	215	246	276	307	337	3
4	4	35	63	94	124	155	4	185	216	247	277	308	338	4
5	5	36	64	95	125	156	5	186	217	248	278	309	339	5
6	6	37	65	96	126	157	6	187	218	249	279	310	340	6
7	7	38	66	97	127	158	7	188	219	250	280	311	341	7
8	8	39	67	98	128	159	8	189	220	251	281	312	342	8
9	9	40	68	99	129	160	9	190	221	252	282	313	343	9
10	10	41	69	100	130	161	10	191	222	253	283	314	344	10
11	11	42	70	101	131	162	11	192	223	254	284	315	345	11
12	12	43	71	102	132	163	12	193	224	255	285	316	346	12
13	13	44	72	103	133	164	13	194	225	256	286	317	347	13
14	14	45	73	104	134	165	14	195	226	257	287	318	348	14
15	15	46	74	105	135	166	15	196	227	258	288	319	349	15
16	16	47	75	106	136	167	16	197	228	259	289	320	350	16
17	17	48	76	107	137	168	17	198	229	260	290	321	351	17
18	18	49	77	108	138	169	18	199	230	261	291	322	352	18
19	19	50	78	109	139	170	19	200	231	262	292	323	353	19
20	20	51	79	110	140	171	20	201	232	263	293	324	354	20
21	21	52	80	111	141	172	21	202	233	264	294	325	355	21
22	22	53	81	112	142	173	22	203	234	265	295	326	356	22
23	23	54	82	113	143	174	23	204	235	266	296	327	357	23
24	24	55	83	114	144	175	24	205	236	267	297	328	358	24
25	25	56	84	115	145	176	25	206	237	268	298	329	359	25
26	26	57	85	116	146	177	26	207	238	269	299	330	360	26
27	27	58	86	117	147	178	27	208	239	270	300	331	361	27
28	28	59	87	118	148	179	28	209	240	271	301	332	362	28
29	29	..	88	119	149	180	29	210	241	272	302	333	363	29
30	30	..	89	120	150	181	30	211	242	273	303	334	364	30
31	31	..	90	...	151	...	31	212	243	...	304	...	365	31

Precept: In leap-years, add one day after February 28. This table is to be used in connection with Table I to obtain the *local date* to the nearest day. Thus, August 10 = 222 days = *Mip*.

THE RATIONAL USE OF COCAINE IN SURGERY.

CLAUDE A. DUNDORE, M.D., Philadelphia, Pa., in Codex Medicus.

THE opinion of the profession, as to the employment of cocaine in surgical practice, has undergone a great change during the past three or four years, and this reaction is not surprising when we consider the many dire results which have followed the indiscriminate use of the drug.

After its local anæsthetic action was discovered, the advantages which it has over general anæsthetics in many surgical procedures were plainly evident, and its utility was fully appreciated; as a result, it was used without regard to quantity or the physical condition of the patient, and as if it were as harmless and devoid of systemic effects as pure water. In the course of a short time we began to read accounts of dangerous symptoms, and even deaths following its use; these reports increasing in frequency until it was almost impossible to peruse a journal without finding the head line, "Dangerous Effects of Cocaine."

The views of the profession now began to change, and papers were published claiming that the systemic effect of cocaine was irregular, and that it could not be depended upon, and being therefore unreliable and dangerous, it should be used only with the greatest caution, if at all.

During the past few years its employment has gradually decreased until, to-day, many surgeons have such a profound dread of it that they refuse to use it in any case whatever.

Cocaine in surgery is a great boon; its great advantages over the general anæsthetics, which it can so often displace, cannot be over-estimated; it has its dangers naturally, as have many other active agents which we daily employ, and would not do without, on that account.

We would not refuse to administer ether when necessary, although its use is fraught with danger and demands unceasing vigil from the most experienced persons. We do not underrate its ill effects and, therefore, use it indiscriminately and carelessly; caution, judgment, experience, govern its administration. Previous to etherization, the patient's history is elicited, his physical condition is taken into consideration, and every precaution is observed to insure him against accident.

The day has come when we should use cocaine with the same care and watchfulness, and while acknowledging its dangers we should guard against them by the means which experience has taught us to employ; as long as it is used without regard to quantity, the site of injection or the condition of the patient, we are bound to have untoward results.

Of over 200 cases of dangerous symptoms and deaths following the injection of this agent, reports of which I have collected from surgical literature, almost one-half received too large a dose; a few were debilitated; in regard to the rest, I do not know whether they were examined physically before the injection, whether they occupied a recumbent position, whether the solution of cocaine was freshly prepared or not; in fact, I do not know, in the slightest degree, whether any care was taken to prevent ill results; therefore, these reports cannot be relied upon as showing the dangers of administering cocaine, and they should not debar any conscientious surgeon from employing it with judgment.

Another fact I would mention, every physiological effect of the drug is not necessarily serious; in both hospital and private practice I have used cocaine, in many cases of every description, without death or dangerous symptoms. I have seen dilated pupils, accelerated cardiac action, pallor, perspiration and some slight evidences of mental exhilaration, but these are no more to be regarded as danger signs than are the flushed face, heavy breathing, and delirious muttering of an etherized patient; they are effects which are always present to a greater or less degree, according to the size of the dose and the susceptibility of the patient.

Some people are naturally more susceptible to its action than others, but our maximum dose must not be large enough to endanger the life of the most susceptible individual.

The first and by far the greatest precaution to be taken, before the hypodermatic injection, is the preliminary physical examination; this should be made with the utmost thoroughness; for to slight it in the least degree may be to permit the occurrence of alarming symptoms, and perhaps the death of the patient, to say nothing of the harrowing effect produced on the brain of the operator. Panas and Magitot state that "cocaine should not be employed in patients suffering from chronic affections of the respiratory pas-

sages, or in those of well marked neurotic diathesis." Reclus says, "It is contra-indicated in brain lesions of long standing, in severe pulmonary cases, in neurasthenia and in epilepsy."

Experience has proved that if the patient is suffering with organic disease of the brain, heart, lungs or kidneys, or any confirmed neurotic disorder, injection of the drug must not be attempted.

A decided nervous temperament is, to my mind, a greater contra-indication to its use than any other condition, with the exception of organic cardiac disease; and it is in cases of this class that we so soon notice physiological effects, even when only moderate doses have been employed. I may state here that Reclus is skeptical about these cases which have been reported of intolerance, for doses of a small fraction of a grain, and questions whether sometimes nervous symptoms, arising from emotional causes, have not been attributed to cocaine.

As to age, if the physical examination shows the patient to be healthy, the mere fact of being advanced in years does not preclude the use of the drug. Wyeth does not regard it as applicable to children of less than ten or twelve years, although Hunter Maguire thinks children bear it better than adults.

The use of cocaine in a considerable number of children, some being as young as three years, without noticeable systemic effects, leads me to believe that it is tolerated fully as well by children as by adults.

The patient should be placed in a recumbent position, with the head low, and he should not be allowed to rise for at least fifteen minutes after the cocaine has entered the general circulation; as it enters at once, when no constriction is used above the site of injection, the patient may be permitted to assume an upright position about fifteen minutes after the injection, or as soon afterward as the operator has finished. When constriction is employed, the patient must be kept in a recumbent position for fifteen minutes after all constriction is removed. By adhering to this method, symptoms of faintness, pallor and vertigo are prevented after the upright position is assumed.

Where it is possible to use constriction, as in operations on the arms, legs, fingers, toes and penis, it should never be omitted. An Esmarch tourniquet or a piece of rubber tubing is to be used, according to the part to be constricted.

After the operation, the method of removing the tourniquet, as described by Barton, should be employed. The tourniquet is loosened and immediately tightened, so that but a small portion of the cocaine contained in the isolated part enters the general circulation. This is repeated at intervals of a few minutes, until the cocaine has probably all entered the circulation in this way, and is disposed of. In this manner, quite large amounts may be used without producing any ill effects. This procedure proves an additional safeguard, inasmuch as a considerable portion of the cocaine is washed away by the hemorrhage if the ligation of the vessels is delayed until after the tourniquet is removed, which should always be done. Of the salts of cocaine the hydrochlorate is mostly used, although the phenate has been used to some extent during the past two years. Van Oepele says of the phenate: "It is more persistent in its effects and less toxic than any other cocaine salts, being less soluble in the water of the tissues." Kyle states that "as it coagulates albumen, it localizes its own action, preventing any extensive absorption of cocaine."

It is antiseptic and needs no addition to the solution to impart to it this quality, but, as to its physiological action, I have not been able to discern any difference between it and the hydrochlorate.

It is desirable to use a freshly prepared solution for each case, as decomposition takes place rapidly, and is not prevented perfectly, even by the addition of an antiseptic. Distilled water only should be used for making solutions, to which may be added either phenic acid, salicylic acid or boric acid, about two grains to the ounce. The dose, in cases where constriction cannot be employed, should never exceed three-fourths of a grain; after a quarter of an hour has elapsed, if the anæsthetic effect is insufficient to render the conclusion of the operation painless, an additional injection of half the first named quantity may be given; for operations about the head, face and neck, one-third of a grain must never be exceeded, and this should not be followed by a second injection. When constriction is used the dose may be considerably increased, varying according to the character of the operation and the vascularity of the site of injection; when the operation is of such a character as to be followed by little or no hemorrhage, the dose should be one grain, and, if the length of the operation requires it, half this quantity may be again used. When there will be considerable hemorrhage after the tourniquet is totally removed, thus getting rid of a large quantity of cocaine, we may use one and one-half grains to be followed after the lapse of fifteen minutes, if absoultely necessary, by a half grain.

The quantities above given should never be increased, and as it is very seldom necessary to administer the second injection, we can insure safety to a greater degree by omitting it. It is rarely necessary to use a stronger solution than two per cent., and by using this strength it is evident that we have a greater quantity of solution to a given quantity of cocaine than if a stronger solution were used, and we are, therefore, able to anæsthetize a larger area of tissue; furthermore, as cocaine is taken up more slowly by the circulation when a weak solution is employed, we are less apt to have any decided systemic effect.

Thirty-five minims, which represent about ¾ grain, are sufficient for almost any operation, unless it be very prolonged.

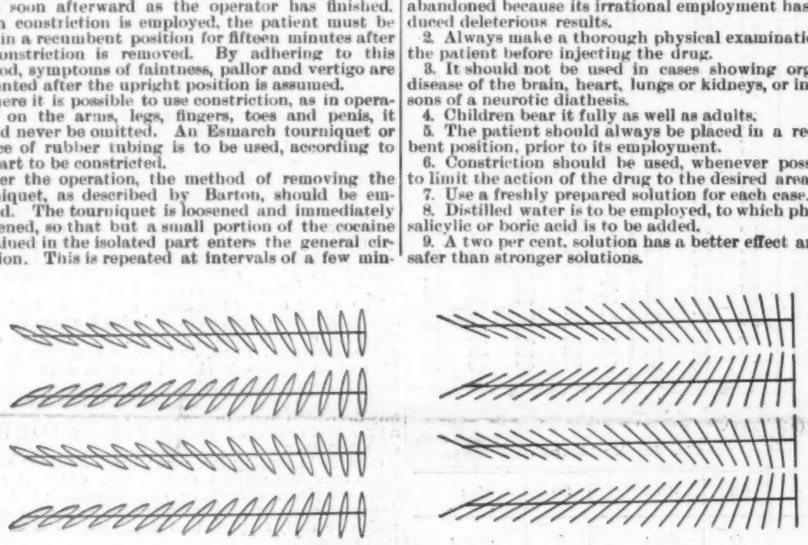
Pernice, and also other writers have stated that cocaine has no anæsthetic action on inflamed tissues; Reclus was the first, I believe, to deny this statement, and he is undoubtedly correct when he claims that while it does not act so promptly, it still has decided anæsthetic effects.

The milder systemic effects of the drug, which may or may not be present, according to the susceptibility of the patient, and are not necessarily alarming, are dilated pupils, accelerated heart action, pallor, perspiration, vertigo and slight mental exhilaration. The symptoms which follow an excessive dose, and which may be cause for grave apprehension, are delirium, convulsions and opisthotonos.

A fatal dose arrests the heart in diastole, and also arrests the action of the muscles of respiration. The principal antagonistic agents which have been used in cases of cocaine poisoning are amyl nitrite or nitroglycerin, strychnin, caffein, digitalis, ether and ammonia; if the expectation of Stickler, of Orange, New Jersey, is realized, we will command an antidote more reliable than any in the above list. He claims that opium is a perfect antagonist to cocaine and has verified his opinion, to a great extent, by observations on numerous human beings, pigeons and dogs.

SUMMARY.

1. The use of cocaine in surgery should not be abandoned because its irrational employment has produced deleterious results.
2. Always make a thorough physical examination of the patient before injecting the drug.
3. It should not be used in cases showing organic disease of the brain, heart, lungs or kidneys, or in persons of a neurotic diathesis.
4. Children bear it fully as well as adults.
5. The patient should always be placed in a recumbent position, prior to its employment.
6. Constriction should be used, whenever possible, to limit the action of the drug to the desired area.
7. Use a freshly prepared solution for each case.
8. Distilled water is to be employed, to which phenic, salicylic or boric acid is to be added.
9. A two per cent. solution has a better effect and is safer than stronger solutions.



AN OPTICAL ILLUSION—PARALLEL STRAIGHT LINES THAT APPEAR SLIGHTLY CURVED.

10. Never inject a larger quantity than 1½ grains when no constriction is used.
11. About the head, face and neck ½ grain should never be exceeded.
12. When constriction is possible, the dose may be as large as two grains.
13. Every slight physiological effect is not necessarily to be taken as cause for alarm.
14. Cocaine does have effect on inflamed tissues.
15. In case alarming symptoms threaten, use amyl nitrite, strychnin, digitalis, ether or ammonia.

OPTICAL EFFECTS OF PARALLEL LINES.

MR. CHARLES BRUNOT, apropos of an article upon optical illusions that appeared in our issue of January 18,* says La Nature, sends us some interesting comments upon some phenomena of this kind that are known. We cannot print his entire article, but extract therefrom the accompanying figures; in which the straight and parallel lines not only seem to lose their parallelism, but appear to be curved.

"If there is any one thing to which the perspective vision of objects has habituated the eye," says Mr. Brunot, "it is the straight line. The latter, in fact, is always preserved intact in perspective. It seems, therefore, that the eye ought never to be mistaken when it is put in the presence of a straight line, and yet such a mischance is not spared it in the [accompanying] figures . . . which I believe that I am the first to publish."

We shall add some general reflections upon optical illusions, says La Nature. These are now well known and have been studied in all sorts of forms in the laboratories of physiologists and physicists; but it must be remarked that, of all such illusions, the most striking is that which is connected with straight lines placed at a distance, and that appear to be slightly curved. In the example furnished by our correspondent, the lines are marked by a series of shorter and slanting ones that certainly act to a great degree upon the eye to produce the striking effects of which we speak. We have also sometimes tried to take only two parallel lines and place them at a certain distance. The effect, without being as distinct as that of which it is a question above, was nevertheless really marked.

An optical illusion of a similar character, in which parallel lines seem to be curved, owing to the effect of irradiation, is described and illustrated in SCIENTIFIC AMERICAN SUPPLEMENT, No. 1049, p. 16773.

* Reproduced in SCIENTIFIC AMERICAN SUPPLEMENT, No. 1053, p. 16886.

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